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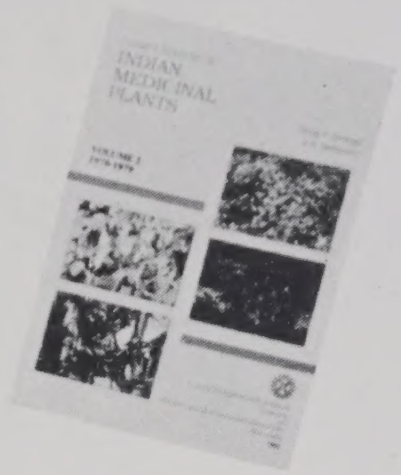

by R P Rastogi and B N Mehrotra

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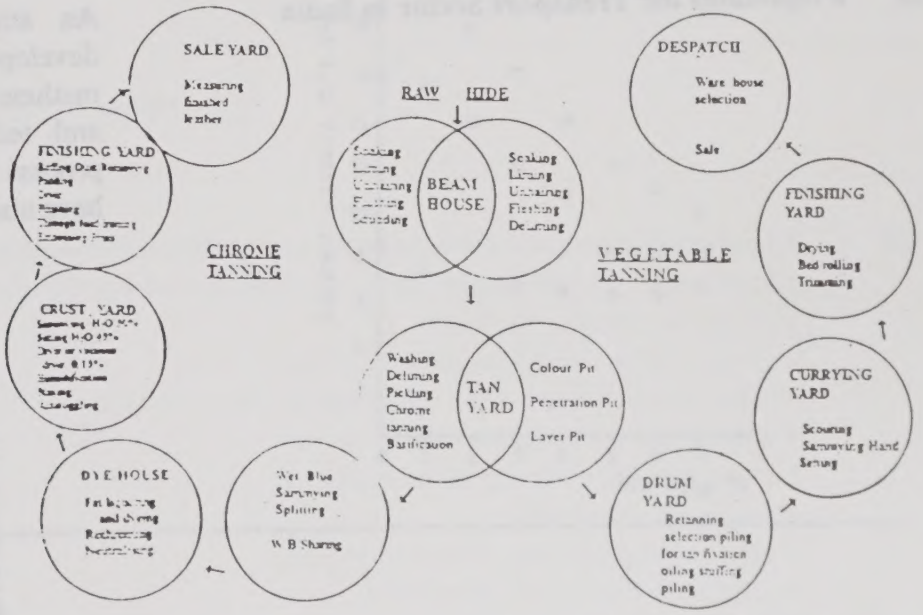

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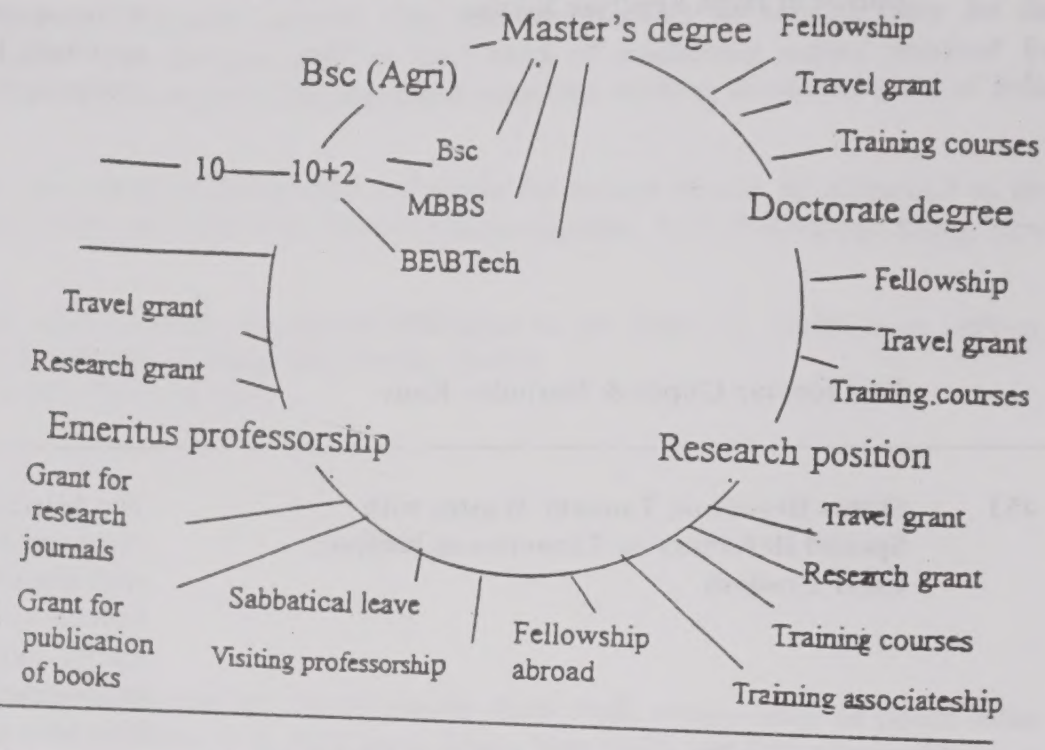

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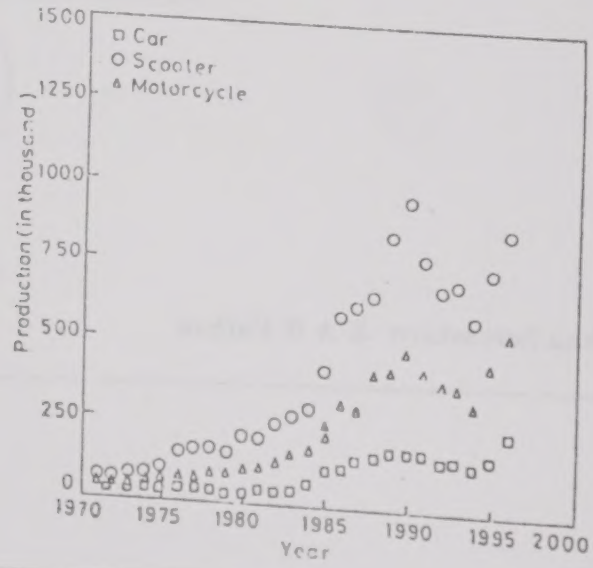

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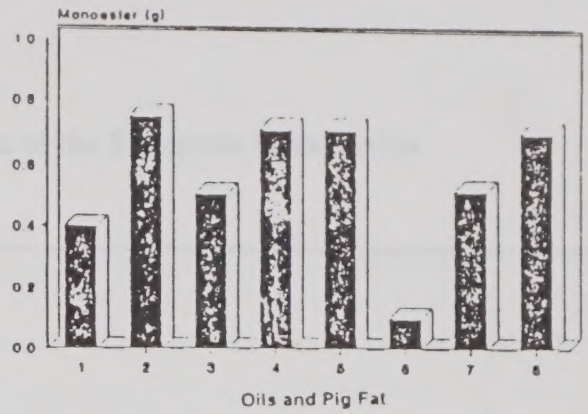

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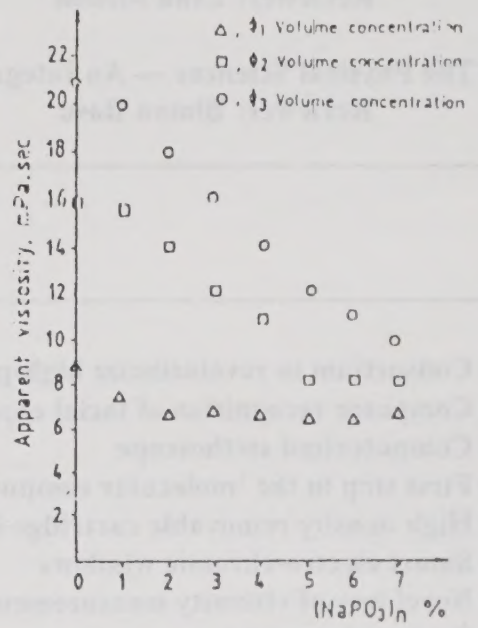

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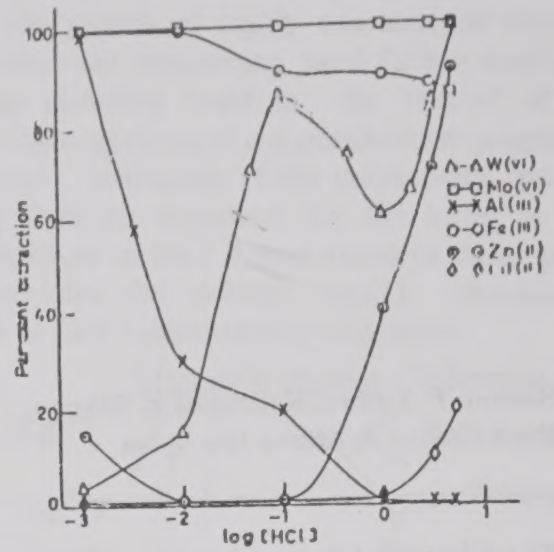

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Fructan Storing Plants — A Potential Source of High Fructose Syrups

Anil Kumar Gupta and Narinder Kaur

Department of Biochemistry, Punjab Agricultural University, Ludhiana 141 004, India

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Conventional method of preparing fructose syrups is based on a multistep process starting from starch. Inulin, a fructose polymer which is stored as reserve material in many plants, could prove to be a better source for producing fructose. The progress made on hydrolysis of inulin by acid and inulinase obtained from microbial organisms has been reviewed. Possibility of using immobilized inulinases for producing fructose has also been discussed.

Introduction

Fructose is the sweetest available natural sugar and is emerging more and more as a safe and an alternative sweetener to sucrose which causes problems related to corpulence, cariogenecity, atherosclerosis, and diabetes[1]. Low levels of fructose can be metabolized without a need for insulin. Thus fructose is suitable for consumption by diabetics and calorie-conscious people who can enjoy the same sweetness with fewer calories. For a long term health programme, a partial replacement of sucrose by fructose is needed.

Fructose increases intestinal absorption of iron to a considerable extent as a result of formation of an iron-fructose chelate complex which is better absorbed than inorganic iron. After a few days on a high fructose diet, an improvement in tolerance to dietary sucrose has been observed in sucrose- intolerant children. Fructose is also being used in food and drink industries. Fructose crystallizes less rapidly than sucrose and thus gives a smoother texture in high sugar or frozen foods[2]. Thus, consumption of fructose syrups has been increasing consistently in the recent past.

At present, most of the fructose syrups available in market are produced from corn starch. Starch is first converted to glucose in the presence of α-amylase and amyloglucosidase followed by glucose isomerase catalysed conversion of glucose to fructose. The sugar syrup thus obtained contains about 42 per cent fructose, 50 per cent glucose, and 8 per cent oligosaccharides[3]. Fructose syrups can also be obtained from sucrose by invertase or acid catalysed hydrolysis. The invert sugar syrup obtained from sucrose has about equal ratio of glucose and fructose. For obtaining high fructose syrups from invert sugar syrup, glucose is separated from the mixture by column chromatographic techniques using Ca^{+2} charged resins which add to the cost of production[4].

An attractive alternative for the production of high fructose syrups (HFS) is by the hydrolysis of naturally occurring fructans, especially inulin. Inulin, like starch is a reserve carbohydrate material of tubers of *Helianthus tuberosus*,[5] roots of *Cichorium intybus*[6], and many other plants. Inulin molecule consists of about 35 units of β 2 → 1 linked **D**-fructofuranose residues terminated by a **D**-glucose unit. Besides, inulin these plants also store other lower fructans varying in degree of polymerization of fructose. Inulin after complete hydrolysis can give a sugar syrup having more than 90 per cent fructose. In this paper, scope of using inulin/fructan storing plants for production of fructose, the progress made so far in this direction, the problems, and the possible approach to solve such problems have been discussed.

The Possible Mode of Approach

Various aspects of inulin synthesis and its depolymerization in chicory roots have been studied[6-10]. For obtaining high fructose syrups, there must be an economical procedure for the isolation of inulin from chicory roots. The composition of chicory roots var-

ies depending upon the growth stage of the plant. Fructans and inulin are accumulated in the roots till the flowering starts[6]. After flowering and during seed formation, fructans are hydrolysed by exoinulinase, resulting in loss of accumulated inulin and increase in free fructose[11]. The roots for extraction and isolation of inulin are to be taken before the start of flowering. Usually, chicory is sown in the middle of October and biomass filling in the roots is complete within 18 weeks after sowing[12]. The roots can be collected during March-April. During this period the roots contain maximum inulin. The roots can then be crushed and inulin and other fructans can be extracted with boiling water[13]. However, this aqueous extract contains some bitter principles. These bitter principles and colour of extract can be clarified using charcoal. From the clear aqueous extract, inulin can be precipitated by ethanol or alternately this aqueous extract can be hydrolysed by acid or enzymic hydrolysis. According to Grootwassink and Fleming[14], acid hydrolysis of fructans is not preferred because of formation of fructose dianhydride which does not possess sweetening property. However, to the authors it does not appear to be a final word on the use of acid for inulin hydrolysis because of the use of cationic exchangers for hydrolysing sucrose at low pH (2 to 3)[15] For hydrolysis of inulin or fructans to fructose by a microbial, exoinulinases is being studied in various laboratories[16-18]. No doubt, inulinase is an enzyme which will be used in near future for production of fructose from fructans or inulin and has all potentials to replace the process of fructose production from corn starch which is a multienzymic process involving adsorption column chromatography for enriching fructose from a fructose- glucose syrup.

Dr (Mrs) Narinder Kaur after completing her PhD in Biochemistry from Punjab Agricultural University (PAU) Ludhiana, joined the Department of Biochemistry, PAU, Ludhiana, as an Assistant Professor in 1977. She worked as a post doctoral fellow (awarded by Danish International Development Agency) in the Department of Biochemistry and Nutrition, Technical University of Denmark, Lyngby, Copenhagen from October 1980 to March 1982. She has been awarded ad hoc research projects from various funding agencies like ICMR, UGC, DST and ICAR in the capacity of Principal Investigator and co-investigator. She has guided four PhD and five MSc students. Her research interests include Biochemistry of abiotic stresses in plants, carbohydrate metabolism in field crops, enzyme immobilization, and fructan metabolism. She has about 40 publications mostly in international journals of high repute. Presently, she is working as a Professor of Biochemistry in the Department of Biochemistry. Punjab Agricultural University, Ludhiana.

Dr Anil Kumar Gupta did his PhD in Biochemistry from Punjab Agricultural University, Ludhiana, in 1979 and thereafter joined the Department of Biochemistry, Punjab Agricultural University as Research Associate in 1979. During subsequent years, Dr Gupta obtained funding from various research agencies like ICAR, DST, ICMR, UGC, and Punjab Government to pursue his research interests. He was also granted INSA Bursary grant to upgrade his laboratory. Dr Gupta was awarded grant by the sponsors of First International Congress on, Food and Non-food Applications of Inulin and Inulin Containing Crops to present his research findings during the Congress which was held at Wageningen, Netherlands in 1991 and FAOB travel Fellowship to present paper at Tenth FAOB Symposium on protein research, held at Taipei, Taiwan in 1993. Dr Gupta has guided four PhD and seven MSc students. His major area of research interests are Biochemistry of fructans and their applications in foods and nutrition, Enzymology of carbohydrate metabolism of plants, Effect of plant growth regulators and abiotic stresses on metabolism, factors determining sink filling in major and minor crops. Dr Gupta has published about 40 papers mostly in International Journals of high repute. Dr Gupta is presently working as a Professor of Biochemistry in the Department of Biochemistry, Punjab Agricultural University, Ludhiana.

Major Inulin Storing Plants

Inulin and other fructans are the reserve materials in many plants. Some important sources of inulin together with their average inulin content, expressed as per cent on a fresh weight basis, are given in Table 1. The concentration on the production of fructose syrups from inulin of chicory roots and tubers of Jerusalem artichoke is being mainly studied.

Acid Vs Enzymatic Inulin Hydrolysis

Grootwassink and Fleming[14] have compared the enzymatic hydrolysis of inulin into fructose with chemical hydrolysis. They observed that if a potent inulinase is available then enzymatic hydrolysis is found to be better than acidic hydrolysis. After enzymatic hydrolysis of inulin, no undesired colour was formed till 4 to 6 h and a slight colour was observed only after 8 h, whereas acid hydrolysis formed at least 5 per cent difructose anhydride which has no sweetening property. However, in fact, both inulinase based and acid based hydrolysis of inulin after isolating it from inulin storing plants or directly from the aqueous extract of these plants should be tried for evolving more suitable technology. For enzyme based technology, a microorganism producing inulinase with high activity, preferably an extra- cellular in nature is required.

Inulinase Producing Microorganisms

Inulinase like invertase is a β-fructosidase which cleaves fructose moiety from the non-reducing end of inulin molecule and is named as 2,1-β-**D**-fructan-fructanohydrolase (EC 3.2.1.7). Invertase specifically hydrolyses sucrose into glucose and fructose and it can be classified as β-**D**-fructo-furanoside fructohydrolase (EC 3.2.1.26). A true invertase will not act on inulin and, similarly a true inulinase will show much less activity with sucrose. In fact, ratio of rate of sucrose hydrolytic to inulin hydrolytic activity of an invertase is more than 5000, whereas for a true inulinase it is less than one. Fungi and yeast when grown on an inulin based growth medium could produce extracellular inulinase. Various microorganisms which have been reported to produce inulinase have been summarized in Table 2.

Table 1 — Per cent inulin content (FW) from some important sources

Source	Inulin, %
Garlic[19]	15-25
Asparagus root[20]	10-15
Salsify[21]	15-20
Jerusalem artichoke[22]	15-20
Dahlia tuber[23]	15-20
Chicory root*	15-20

*Our own unpublished results

Table 2 — Some important sources of inulinase producing microorganisms

Microorganisms	Units ml^{-1} medium
Kluyveromyces fragilis[24]	2.0
Bacillus[25]	1.1
Clostridium acetobutylicum[26]	0.4
Kluyveromyces fragilis[27]	70
Aspergillus niger[28,29]	7-8

Table 3 — Solubility of inulin from chicory roots at diffe temperatures

Temperature, °C	Inulin solubility (%, w/v)
30	1.5
40	2.6
60	10.2
80	18.1
90	25.4

From Table 2, it is not easy to compare various organisms for their capacity to synthesize inulinase because of variations in the assay system. Most of these activities have been assayed at 37°C at which inulin is less soluble (Table 3). From Table 3, it is evident that considerable amount of inulin can be dissolved at about 60°C. Therefore, for industrial applications, inulinase must have high optimum temperature and good thermal stability so that it can act

on 10 to 20 per cent solution of inulin at the above temperature. If inulinase has a low optimum temperature, it will act only on dilute inulin solution. The cost of concentrating such a dilute fructose syrup after complete hydrolysis of inulin may not be encouraging. Authors have identified certain *Aspergillus* strains which have very high stability at 70 and 80°C[30]. However, these strains do not produce high quantity of inulinase. The extracellular inulinase production is around one unit ml^{-1} of the growth medium which does not appear to be high enough for industrial use. Some biotechnological innovations of incorporating the genes of thermally stable inulinases into fast growing yeast or bacteria are required so that thermally stable enzymes can be produced in abundance. A comparison of thermal stability of inulinases from various microorganisms has been given in Table 4.

Potential of Immobilized Inulinases for Production of Fructose from Inulin

Use of soluble inulinase in hydrolysing inulin will not be economically viable in industry because of the loss of enzyme during this conversion. The immobilized inulinase offers the prospective of its reuse several times after separation from inulin hydrolysed fructose syrup by a simple filtration process. Furthermore, immobilization of enzymes sometimes leads to change in their properties like increase in temperature optima and thermal stability, which could be beneficial to the industry. The thermal stability of various immobilized inulinases and the techniques used in immobilization have been summarized in Table 5. The immobilized inulinase though has not been used for producing fructose commercially, but it has bright prospects because of the presence of inulin in abundance in nature.

Table 4 — A comparison of thermal stability of inulinases from different sources

Source of inulinase	Remarks on thermal stability
Chrysosporium pannorum[31]	Stable for 10 min at 50°C
Panaeolus papillonaceus[32]	Stable for 1 h at 50°C
Kluyveromyces marxianus[33]	Half-life 30 min at 60°C
Clostridium acetobutylicum[34]	Completely denatured after 10 min heating at 55°C
Debaryomyces cantarellii[35]	Half- life 12-14 min at 55°C
Pichia polymorpha[36]	Completely denatured after 5 min heating at 70°C
Kluyveromyces fragilis[37]	Half life 20 min at 60°C
Aspergillus niger[38]	62-65 per cent activity after 2 h at 65°C
Fusarium oxysporum[39]	Denatured in 15 to 20 min at 50°C
Kluyveromyces fragilis[27]	Half-life 50 to 60 min at 55°C
Aspergillus aureus[30]	Lost 15 per cent activity after 2 h heating at 70°C

Table 5 — A comparison of thermostability of immobilized inulinases from diverse sources

Source of inulinase	Immobilization process	Thermal stability
Kluyveromyces marxianus[40]	Bound to a molecular sieve via metal link method	At 60°C about 30 per cent activity lost in 140 min at 65°C, 70 per cent activity lost in 30 min
Kluyveromyces fragilis[41]	Bound to amino ethyl cellulose using glutar-aldehyde	Activity decreased rapidly at temperature above 50°C
Kluyveromyces marxianus[42]	Inulinase active cell entrapped in Agar gel	At 60°C about 70 per cent activity lost in 90 min and at 65°C about 90 per cent of activity lost in 30 min
Fusarium oxysporum[43]	Bound to DEAE-cellulose	Lost 50 per cent of activity at 50°C in 45 min
Aspergillus[44]	Bound to charcoal using tannic acid and glutaraldehyde	—
Kluyveromyces fragilis[27]	Bound to cellulose via metal link method	Lost 50 per cent of activity at 50°C in 15-45 min

Note: — not determined

Attempts to Develop Technology for the Production of Fructose from Fructan Storing Plants

Grootwassink and Fleming[14] extracted inulin from the tubers of Jerusalem artichoke and then hydrolysed it either enzymatically with inulinase or with acid. Decolourization and purification of the syrup are performed by subsequent passing of the syrup through an anion exchanger (pH increases to 9.0), a cation exchanger (pH drops to 3.0), and again through a weak anion exchanger (pH increases to 5.0).

Kierstan[45] obtained fructose syrup from inulin storing plants by different procedures. Here, after extraction of inulin from plant sources, $Ca(OH)_2$ is added to inulin solution to increase its pH to 11. Most of the non-inulin contaminating components precipitate and can be eliminated by centrifugation. The main advantage of refining inulin before hydrolysis is that after hydrolysis the obtained syrup is much easier to purify. A single filtration step over activated charcoal yields the end product.

Barta[46] has given a simple way of preparing a concentrate from tubers of *Helianthus tuberosus* which contains around 80 per cent fructose. This technology is based on clearing the aqueous extract of tubers with $Ca(OH)_2$ and then removal of Ca^{2+} by cation exchanger which leads to lowering of pH and then hydrolysis of fructans at low pH, and removal of anions by anion exchange chromatography.However, fructose production by acid hydrolysis and use of ion exchange chromatography also removes natural ions. There is a need to develop a technology, without use of an ion exchanger, using inulinases so that final concentrate should possess all the mineral components of the juice.

Recently, production of natural concentrate from Jerusalem artichoke with high fructose level of 75-80 per cent and mineral content rich in K, Mg, Zn, and Cr by using inulinase of *Aspergillus* origin has been reported[47]. The product has been proved to be beneficial for human health, especially for diabetics, high blood pressure, and gout[47].

A Comparison of Chicory, Sugarcane and Potato for Fructose Production

The economic feasibility of producing high fructose syrup from the roots of chicory depends on its ability to compete with similar products in the market. Therefore, a comparison of possible yields of fructose from one hectare of land cultivated under chicory, sugarcane and potato has been made. The yield of chicory roots (dry biomass) varied from 10.6 to 16.5 tonnes/ha depending upon the cultivar[48]. Inulin content on dry weight basis of roots was about 74 per cent in these cultivars and inulin content obtained from them varied from 8 to 12 tonnes/ha which after complete hydrolysis yielded 9 to 13 tonnes of fructose. An average yield of sugarcane is 75 tonnes/ha and sucrose recovery is about 10 per cent resulting in 7.5 tonnes of sucrose. Therefore, invert sugar syrup obtained from sucrose will results in 4 tonne each of glucose and fructose from the crop obtained from one hectare of land. An average potato production of different cultivars is about 25 tonnes/ha. Considering the average starch content of potato, about 14% on fresh weight basis, one hectare of land will yield about 3.5 tonnes of starch which can at the best give about 2.8 tonnes of fructose. Of course, diversion of potato for fructose production will depend upon the market price of potato. Comparing the above data, it can be argued that there is an earnest need to develop technology for the production of fructose from inulin based crops.

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Status Report on Tannery Wastes with Special Reference to Tanneries at Kanpur, Uttar Pradesh

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The distribution of tanneries, their tanning modes, effluent characteristics and their management in various districts in the country with special reference to UP have been described. Salient features of the Upflow Anaerobic Sludge Blanket (UASB) reactor along with various other methods being adopted by tanneries in the country for the treatment of effluents have been discussed.

Introduction

India occupies a key position on the world map with respect to the number of tanneries. There are about 2000 major tanneries in India. Leather is a highly labour-oriented industry and is amongst the major thrust areas for export. This industry comprises (i) Organised Sector units associated with Directorate General of Technical Development (ii) Small Scale units registered with State Directorate of Industries and (iii) Unregistered Small Scale and cottage sector units which form a major part of the industry. The huge animal population in the country, contributes to the large production of hides and skin. It is estimated that around 3/4 million kg of skins are processed annually. Tannery effluent is among one of the dangerous pollutants of industry. Approximately 3000 l of wastes/100 kg hides processed, is discharged and annual discharge amount 09,420 Kl[1].

Major contribution to tannery wastes is made by beam house and, tanyard operations, which include wet salting, dry fleshing, deliming, bating, fat liquoring, vegetable or chrome tanning. Each of these processes produce characteristic wastes of which tannins present in tan liquors are principal constituents, toxic to the biota. Tannins may accumulate upto a concentration of 6,400 mg.l^{-1} in the effluent[2]. Apart from tannins, the presence of high levels of total solids (6000-8000 ppm),high BOD and hardness, high levels of chlorides and sulphates cause adverse effects on animals, microorganisms and plants. Chlorides cause chlorosis in plants and increase in the levels of sulphides, increases the sodium adsorption ratio resulting in disturbed soil structure and plant growth. When present in high levels, the possible entry of chromium into the food chain may cause serious harm to the human and animal metabolic system. It is known to cause nausea, skin irritability[3], and skin ulcerations even in small amounts (10 mg/l). Hexavalent chromium may lead to lung carcinoma and trivalent chromium is unstable with additional oxygen demand on water bodies. Excess of chromium interferes with the waste water treatment to a great extent[4,5].

The polluting wastes of tanneries result in losses in agricultural output, fisheries as well as in tourism. Government's intervention to take control of the polluted environment has resulted in the promulgation of Water Prevention and Control of Pollution Act, 1974 which is applicable to all the Union Territories and States in India. In Uttar Pradesh, U.P. Pollution Control Board looks after the effluent status of industries and enforces measures to control the pollutants from time to time. It may be recalled that 29 tanneries near Kanpur and Unnao were closed down in the year 1977 by orders of the Supreme Court. Similarly in other states, steps have been taken to curb pollution. In February,1995 in Calcutta; 538 tanneries have been asked to relocate outside Calcutta, in Tamilnadu, 700 tanneries have been re-

ported to make the farmland sterile and as many as 57 tanneries were shut down in May, 1995[6].

Tanning Mode

More than 250 chemicals are used in tanning. Different types of leathers are manufactured in the industry which are tanned by basically two methods viz, chrome tanning and vegetable tanning. When light leather is preferred, chrome tanning is used, whereas vegetable tanning produces heavy leather. During chrome tanning, large amounts of basic chromium sulphate used, makes the leather tough and resistant. Large amounts of waste water are generated in this process to wash out residual salts which might interfere in the quality of finished leather products. However, in vegetable tanning, popular materials like wattle, myrobalan, avaran, konnam, etc are used. These vegetable tannins are environmentally friendly in nature producing plumper leather which is easily moulded and less affected by body respiration or changes in humidity. Vegetable tanning procedure is a lengthier process compared to chrome tanning.

Chrome Tanning Process

The chrome tanning process consists of various operations in the (i) beam house (ii) tan house, (iii) blue yard,(iv) dye house, (v) crust yard, (vi) finishing yard and (vii) sale yard operations. Raw hides are soaked and limed in pits, then they are unhaired and after fleshing and scudding, moved to tan house. Here the hides are washed delimed and pickled before chrome tanning and basification. These operations are carried out in drums and then the hides are moved to the blue yard. Various steps including wet blue (WB) sammying (with 50% H_2O), splitting and WB shaving take place. The hides are next processed in dye house and crust yard where they are neutralized, chromed, fat liquored and dyed. Then sammying (H_2O, 50%), and setting (H_2O, 45%) and vacuum drying (H_2O, 15%) are done. Dry storage of the hides is preferred. The dry hides are humidified (H_2O, 22%) staked and auto toggled before reaching the finishing yard. In the finishing yard buffing, dust removing, padding drying finishing and embosspressing are done. Measuring of the finished leather is carried out in the sale yard operations, (Fig-1).

Constituents of Chrome Tan Liquor

Each kilogram of hide/skin processed produces almost 4-5 l of chromium waste water[7]. The liquor is acidic and greenish in colour and pH is reported to range from 2.6- 4.0. The total suspended solids are in the range of 1500 to 2400 mg/l and approximately 500-5500 mg/l trivalent chromium is present, BOD ranges from 800- 3,500 mg/l[7,8,9]. COD is reported to be 1916 and colour in pt co units is 3450[10].

Vegetable Tanning Process

In the vegetable tanning procedure, the different operations are carried out in the (i) beam house, (ii) tanyard, (iii) drum yard (iv) currying yard and (iv) finishing yard. The whole process takes around 70 days to be completed. The beam house operation takes about 11 days in which the raw hide is soaked in a pit for one day, followed by 7 days in lining pit and one day each in unhairing beam and fleshing beam. Both these processes are done manually and then the hide is delimed in a drum for 8 h. Tan yard operation includes treatment of hides for 7 days in the colour pit and 20 days each in penetration and layer pit. Retanning is done for a day in the drum yard and two days are given for tan fixation. The next step is oiling and stuffing which takes 4 h after which piling is done for a day. In the currying yard, the hide is manually scoured for a day prior to sammying and hand setting. The hide is dried and bed rolled for compression, trimmed, selected and despatched for sale, (Fig-1).

Constituents of Vegetable Tanning Wastes

The vegetable tanning wastes are brownish in colour and are characterized by their highly alkaline nature, high pH (7.46 - 8.47), high BOD (1555-3310 mg/l), high COD (320-7700 mg/l) and total solids (33610 mg/l). The total nitrogen content is reported to be 1275 mg/l, total phosphorus 1.26 mg/l, sulphate - 1170 mg/l, chloride 3010 - 6213 mg/l and tannin 480 mg/l[11,12]. Tannins are sometimes accumulated upto a concentration of 6400 mg/l in tannery wastes. These tannins are toxic to plants, animals and soil microorganisms[2,13].

Tanneries in Tamil Nadu

As many as 700 tanneries have adversely affected the farm land.in five districts of Tamilnadu making them sterile. The judiciary has intervened and strict

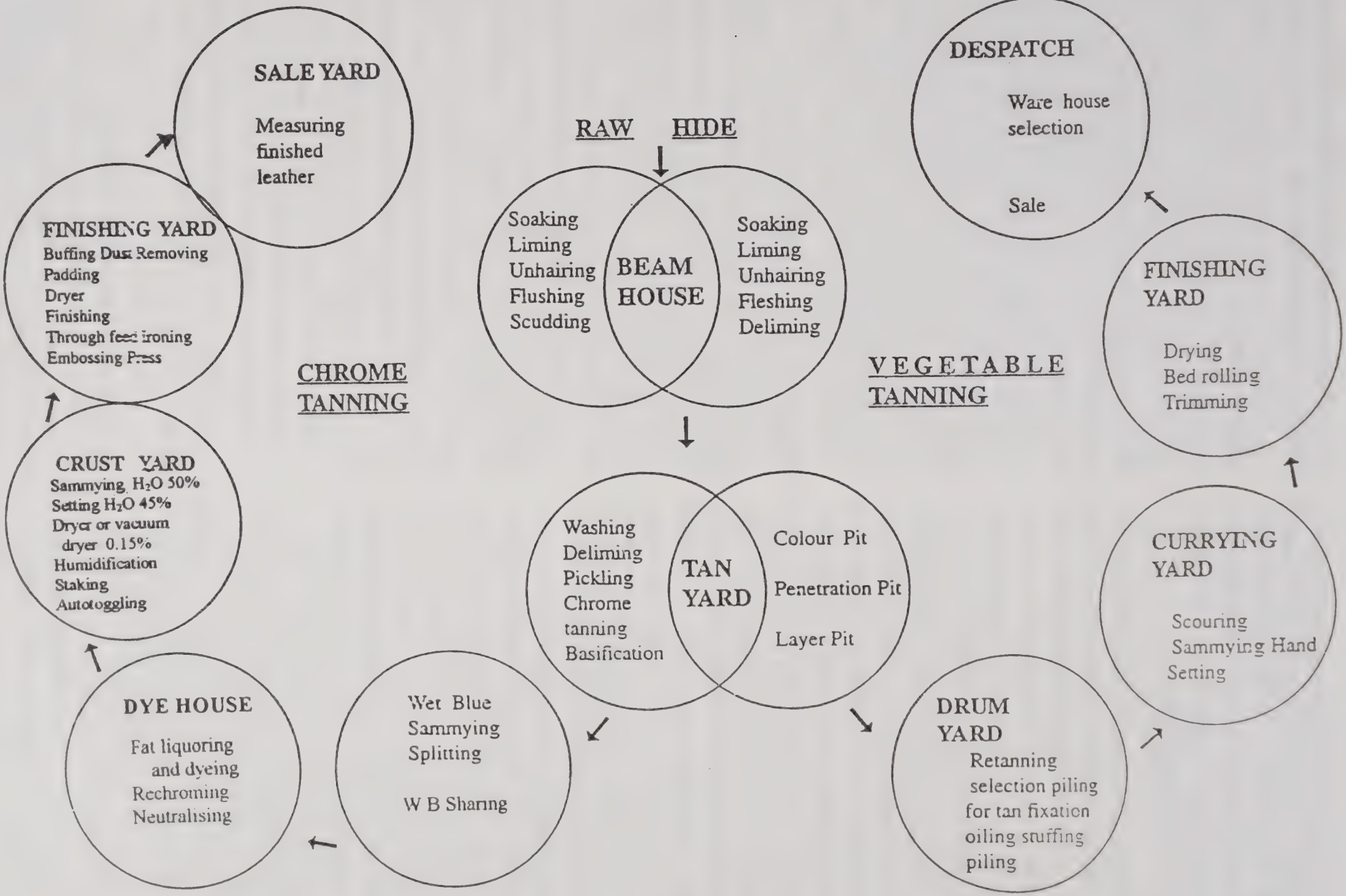

Fig. 1–Tanning mode

judgements have resulted in the closure of 57 tanneries in May 1995, and 496 were given more time to set up ETPs. Only 7 of 30 ETPs are up and running. Supreme court ordered closure of 419 more tanneries in five districts. This has caused a direct loss of over Rs.200 crore to the tanning industry.

Location of Tanneries and Survey at Kanpur

The maximum number of tanneries are concentrated in three states in India, viz., Tamilnadu, West Bengal and Uttar Pradesh. The enormous pollution load along with the toxic nature of effluents make the tanneries a potential threat to the areas in the vicinity of their location. This creates a serious situation disturbing the ecological balance In Uttar Pradesh, tanneries are located mainly in Kanpur, Ghaziabad, Agra, Bareilly, Barabanki and Unnao. Majority of these tanneries are in Jajmau area of Kanpur. The U.P. pollution Control Board has listed 167 tanneries in Kanpur alone. Out of these, 165 have claimed to possess effluent treatment plants. Most of these tanneries (155 tanneries) are small sized with a production capacity ranging between 0.75 - 200 metric tonnes, the smallest being M/s N.R. Tanneries at Durgah Sharief Road. There are 11 medium sized tanneries with a production capacity ranging between 200-650 metric tonnes. The single large sized tannery is M/s Super Tannery with a maximum production capacity of 760 metric tonnes. Exclusively chrome tanning is practised in as many as 101 of these tanneries, 30 tanneries use both chrome and vegetable tanning procedures and in 36 tanneries both forms of tanning are practised. chrome tanning is done faster than vegetable tanning hence the industries have adopted it as a method of choice. Vegetable tanning, though cumbersome utilizes environmentally friendly chemicals. Hence wastes generated are less toxic as compared to chrome tanning procedure. The presence of strong colour, obnoxious smell, high BOD, pH variation and high amounts of dissolved salts in the tannery wastes, ultimately pollute the rivers into which they are discharged. This has now been recognised as a grave problem which can cause irreversible damage to the water environment, if not controlled effectively. This has triggered the need to devise cost-effective pollution minimization programme and launch a cleanliness drive in the industries, suggestions and implementation of time and cost- effective steps to treat the effluents for their safe discharge into the environment.

Effluent Treatment Plants in Tanneries

Most of the tanneries at Kanpur have only primary treatment plants (PTPs). These are designed to remove or reduce in size the large suspended and floating organic solids and adjusting the pH by physicochemical methods like chemical coagulation, precipitation, use of catalyst (manganous sulphate), sorption etc. Though there are other methods like ion exchange and membrane separation, these are highly expensive, hence are not commercially viable in India. These are not being used in these tanneries. Problem of treatment becomes serious because even where PTP are installed, they are not functioning. These erring industries have installed PTPs merely to protect themselves from judicial interventions.

Installation of Chrome Recovery Plants

Large amounts of chromium are used in tanning. Some research reports have appeared on low waste chrome tanning[14]. As stated earlier, mostly chrome tanning is practised at Kanpur. Basic chromium sulphate is used for the purpose and this results is discharge of spent chrome in the wastes. Persuasion of the Government has led to the initiation of recovery process of chromium from the wastes in a few tanneries. This has a two fold objective, viz., (i) Chromium pollution in the waste is minimized and (ii) chromium is recovered for reuse in the tanning process. The tanneries which have adopted this procedure have installed a chromium recovery plant which has a capital cost of 3-4 lakhs. These tanneries are Super Tannery, Pioneer Tannery, Zaj Tannery, Sultan Tannery and Asia Tannery. The Chrome recovery plant efficiently recovers chromium and converts it to powder form. This is later used in tanning operations. The effluent treatment in this plant is nearly free of chromium. Chromium is recovered to the extent that the cost of the plant is recovered in two years.

Combined Treatment Plant (CTP)

Highly advanced anaerobic procedures have been developed in the past few years. Recently, innovative reactor designs in anaerobic treatment technology has made it recognizable as a cost effective mode of effluent treatment[15,16]

The effluent from the individual tanneries after primary treatment, is passed through a conveyor system and brought to the Combined Treatment plant (CTP) for further treatment. The CTP was constructed and commissioned in April 1989 with Dutch Assistance under Indo-Dutch co-operation programme. The proposal was to treat 9 MLD sewage water by Upflow Anaerobic Sludge Blanket (UASB) technology Currently, a demonstration plant of 5 MLD capacity functions with UASB treatment technology. Tannery effluent, after primary treatment is pooled up in equalization tanks from where it flows into division box. Here the flow is proportionally distributed to three compartments (total volume 1200m^3) of the UASB reactor (Fig 2). The conveyor pipes are made of fibre reinforced plastic. Each reactor is fed by a pair of pipes through which the effluent runs at alternate intervals. This allows for the cleaning of scum during the interval when the pipe is not in use. The hydraulic retention time is 6 h. In the UASB Reactor, hydrolysis, acidification and methanogenesis occur. Mixed culture of bacteria like *Methanothrix, Methanosarcina* actively treat the waste to produce methane which is collected to generate electricity. The electricity produced is utilized to meet part of the requirement of the UASB reactor.

Salient Features of the UASB Reactor

The process is basically anaerobic treatment system with a reactor capacity of 1200m^3 and detention time of 6 h. It concentrates at optimising contact between waste water and sludge to achieve efficient sludge retention in the bioreactor. Waste water inlet is at the bottom and flow is upward through a bed of anaerobic sludge. Particulate matter is absorbed during the passage and dissolved material is absorbed and digested by anaerobic bacteria. The upper part of the reactor has a gas solid separator system from where gas is forced into gas collectors and is withdrawn. The reactor has low space requirement as well as low sludge production. The design is relatively simple with few electromechanical parts. It has the capacity to withstand power failure. It has low operation and maintenance cost and the sludge is digested much quicker in comparison to the conventional digestor. During the treatment process in the reactor electricity is generated. The dried sludge is rich in nitrogen, phosphorus and potassium and is sold as fertilizer. The treated water is used for irrigation purpose. No foul odours are present in the treated sludge which is flocculent in nature. This technology shows promise since it is very suitable for tropical areas like India where the ambient temperature does not generally fall below 10°C. The simplicity of the process and low operative and maintenance costs, generation of gas electricity and bio_conversion of wastes into fertilizers promise a vast potential for the treatment of tannery effluent in comparison to the conventional treatment process.

Conclusion

Waste treatment aims at removal of unwanted component in the waste water for safe discharge into the environment along with material and energy recovery and water recycling. Many methods are used to achieve odour free, colourless, treated waste effluent, meeting the standards of the Pollution Control Boards thereby ensuring a safe environment. Physicochemical methods include screening, sedimentation skimming, precipitation flocculation, pH adjustment coagulation adsorption, oxidation and reduction to remove toxic materials[17]. Tannery industry in India has made tremendous strides in developing newer and quicker processing technologies. Biological methods are widely accepted owing to their low cost[18,19,20,21] Several types of bioreactors are in use, which include aerated lagoons, oxidation ditches, activated sludge, trickling filters, anaerobic digestion tanks, oxidation ponds etc. Use of mixed cultures[22], by development of mixed culture inoculum by enrichment or genetic engineering is becoming popular. Immobilized whole cells, cell entrapment are being recognised as potential contributors to the treatment methods[23].

Significant advances in anaerobic technologies are becoming highly popular. A major consideration to this technology is low synthesis rate of microorganism highly cost effective designs with generation of gas and electricity. Study of the treatment processes suggested that for effective treatment of the effluent, a combination of cost effective waste treatment processes is essential.

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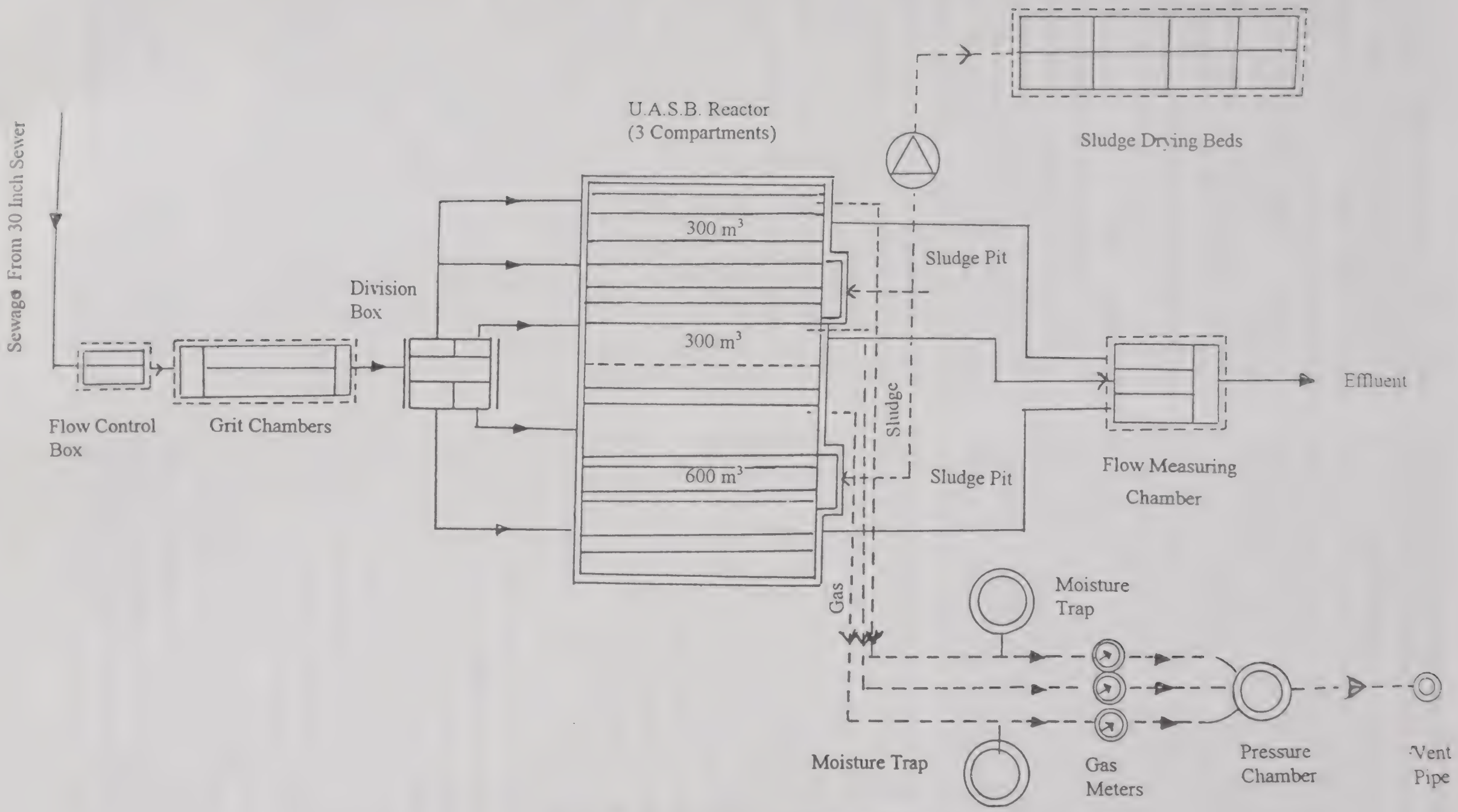

Fig.2–Lay out of 5 MLD UASB treatment plant

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An Approach for the Development of Human Resources in the Field Of Science and Technology in India

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Higher education has made great strides over the period 1950 to 1996. In the past 50 y, India has simultaneously emphasized on primary, secondary, and tertiary levels of education for its people. The programmes to support doctoral and postdoctoral education have led to a stock of scientists and engineers that amounts to on an average about two persons holding bachelor, master and/or doctorate degree in science, agriculture, engineering and medical sciences for 1000 living persons. The ongoing programmes for sustaining the growth of highly educated personnel for R&D in science and engineering need further emphasis in view of the declining trend in the interest of fresh graduates to take up doctoral and postdoctoral programmes in the sciences. The skills of the scientists and engineers manning the research institutions have to be kept sharpened through suitable arrangements for their training and retraining. Interaction of the universities and R&D institutions must be improved for the latter to more actively participate in the S&T human resource development. The industry should shoulder the expenditure on S&T related tertiary education.

1 Introduction

The overall goal of science and technology (S&T), research and development (R & D), and training institutions of the country is to generate new scientific knowledge, to develop and adopt technologies suitable for introducing profitable products to the market and to achieve self-reliance in the strategic areas of development. Considerable progress has been made in building up of human and information resources and infrastructure for meeting the requirements of the above mentioned objectives of the country. The present paper discusses the following aspects of human resource development in S&T in the country: (i) quantitative growth at the various levels; (ii) schemes for the improvement in the quality of the skills of the existing faculty and desirable new endeavours.

2 Growth of Higher Education in Science and Engineering Disciplines

Literacy has been found to have positive effect on the attitude of people towards education of their wards. Parental support remains a critical factor for both school and college education in India. Since the school education forms the basis of higher education, the size of enrollment for higher education as shown in Fig.1 depicts the growth of literacy and higher secondary school (10+2 level) education from 1950 onwards. Both literacy and 10+2 level education have been growing exponentially. The growth in numbers of recipients of bachelor, master and doctorate degree in natural, engineering, medical, and agricultural science areas is depicted in Fig.2 and that for master and doctorate degree holders in biology, chemistry, physics, and mathematics is given in Fig.3. In Tables 1-3, data on out-turns of bachelor, master and doctorate degree holders for the years

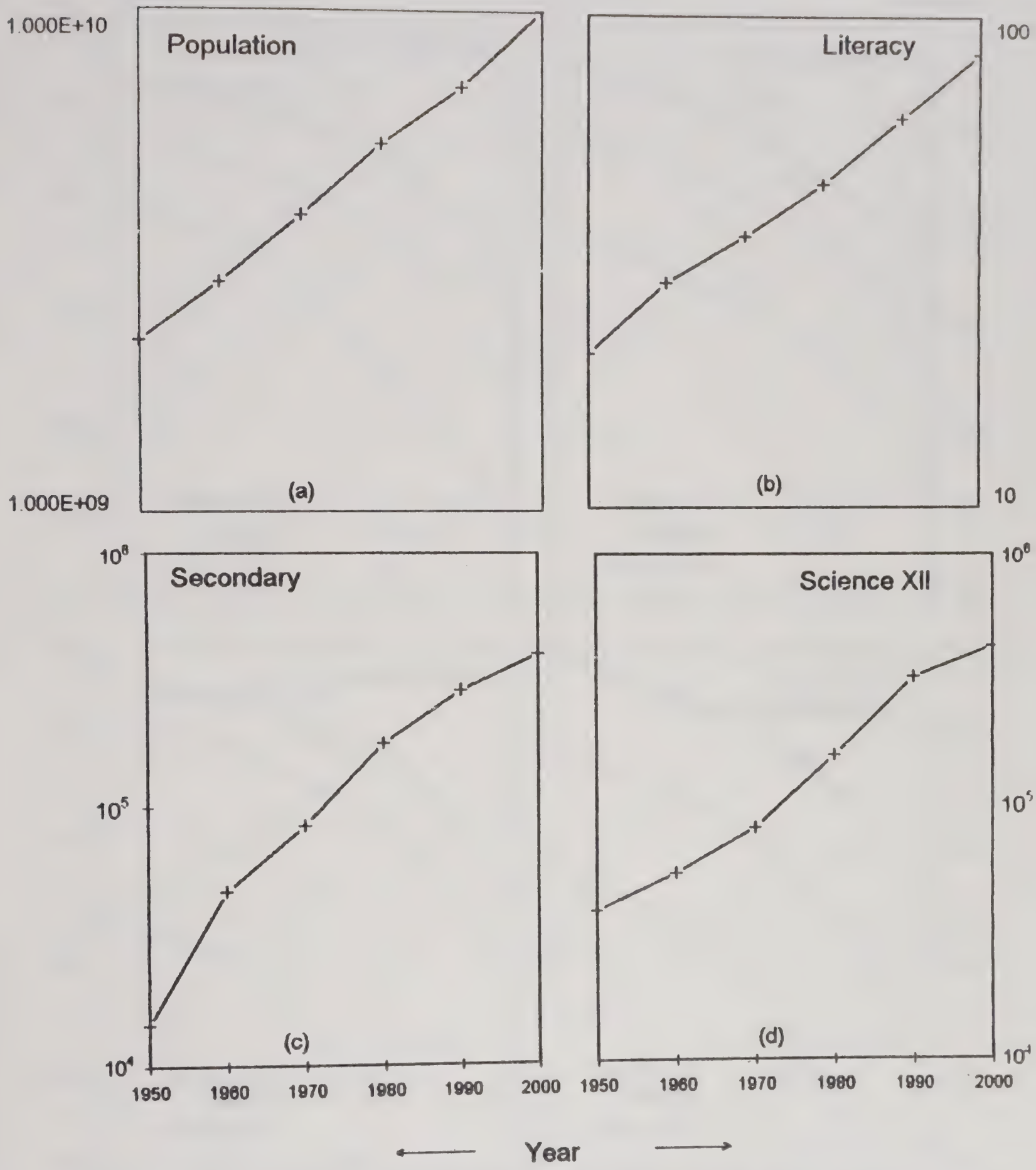

Fig. 1 — (a) Growth of population, (b) literacy, (c) higher secondary education in general, and in (d) science over the period 1950-2000

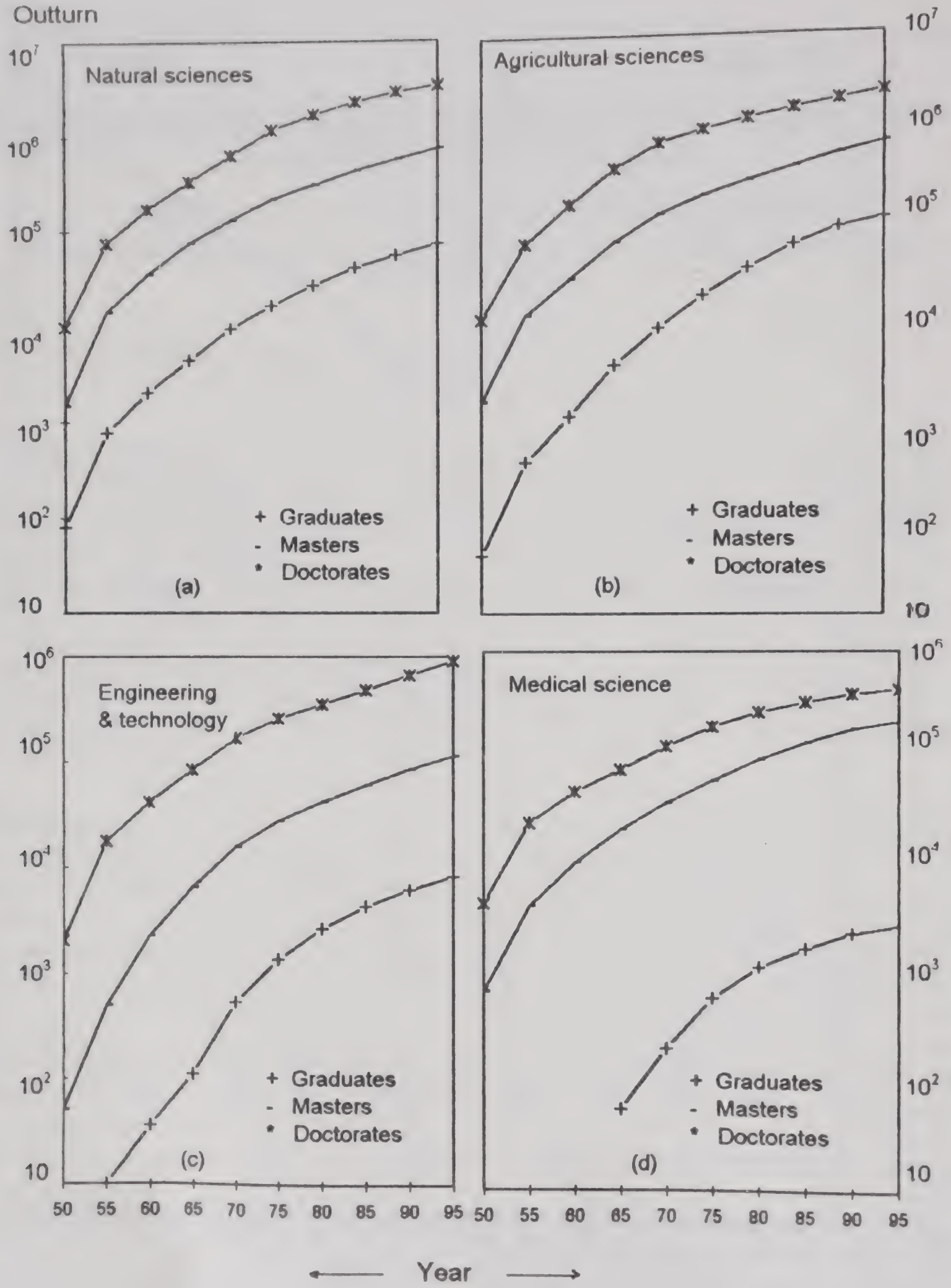

Fig. 2 — Cumulative increase in number of persons holding Bachelors degree, Masters degree, and PhD degree over 1950 to 1995 in : (a) Natural sciences; (b) Agricultural sciences, (c) Engineering sciences, and (d) Medical sciences

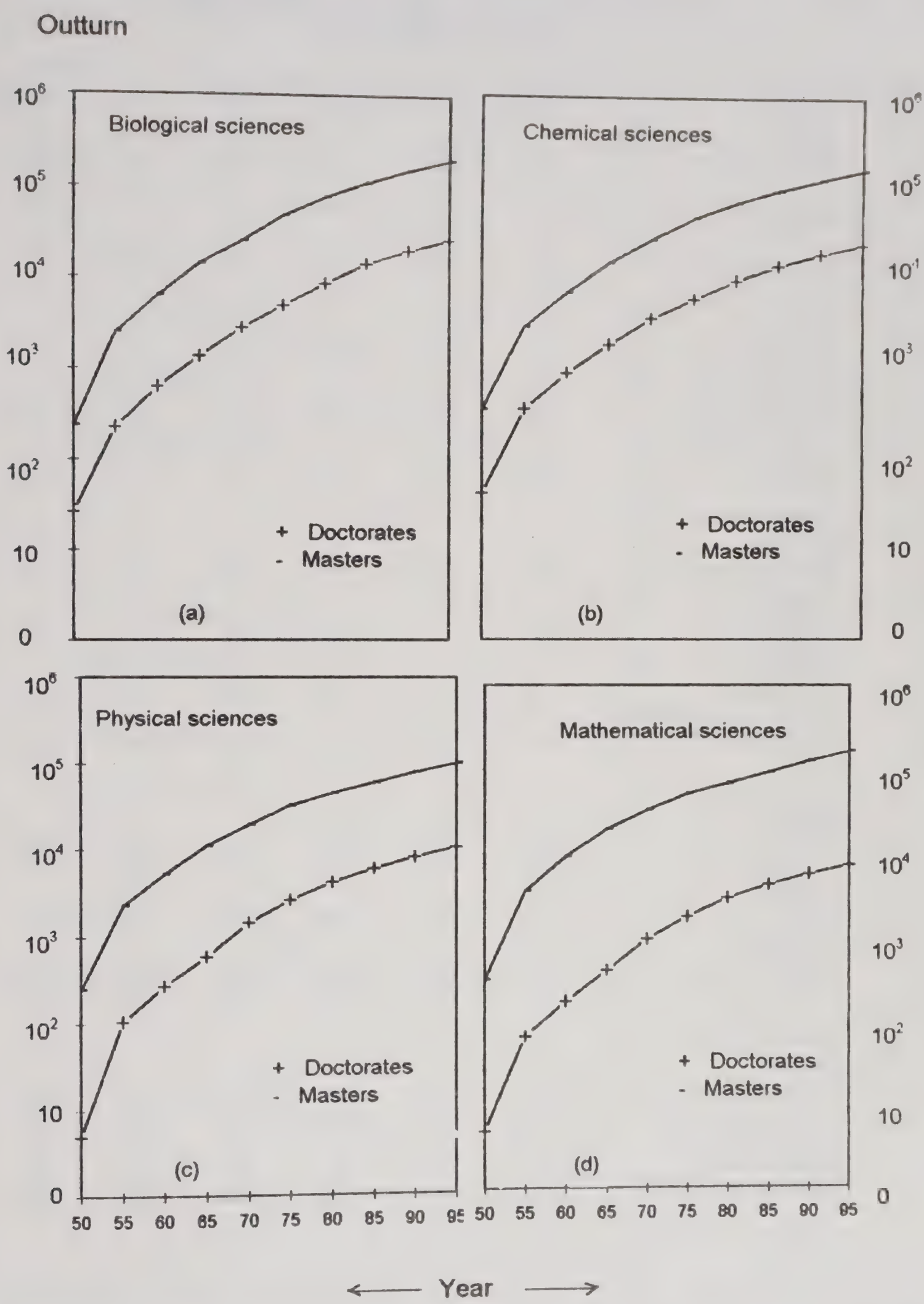

Fig. 3 — Cumulative increase in number of persons holding Masters and Ph D degree in Natural sciences over 1950-1995: (a) Biological sciences: (b) Chemical sciences: (c) Physical sciences, and (d) Mathematical sciences

Table 1 - Trends in the growth of secondary and higher education in science and engineering disciplines in India

Sl. No.	Parameter	Calendar year 1950	1960	1970	1980	1990	2000*
1	Population (x 10^6)	359	434	541	679	816	1042
2	Literacy, %	16	24	29	36	52	70
3	Life expectancy at birth, y	41.3	45.6	49.7	54.4	60.0	65
4	Out-turn of :						
	(a) Secondary level graduates (x 10^2)	1454	4717	8422	18000	29000	40000
	(b) Secondary science graduates (x 10^2)	756	1255	2297	6293	18600	28000
	(c) Diploma E & T	2035	7862	18189	30075	63794	79200
5	Out-turn at bachelors level in the :						
	(a) Natural sciences(x 10^2)	96	227	826	1248	1480	1800
	(b) Agricultural sciences (x 10^2)	11	28	84	73	87	100
	(c) Engineering sciences (x 10^2)	20	57	193	212	417	610
	(d) Medical and paramedical sciences(x10^2)	16	61	161	209	251	300
	(e) All sciences (x 10^2)	143	373	1264	1742	2235	2810
6	Out-turn at masters level in the :						
	(a) Natural sciences	1438	5365	13214	19812	30000	36000
	(b) Agricultural sciences	154	482	1581	2020	2886	3500
	(c) Engineering sciences	50	550	2199	2960	5339	7684
	(d) Medical sciences	164	754	2375	6483	7987	9000
	(e) All sciences	1806	7151	19369	31275	46212	56184
7	Out-turn at doctorate level in the :						
	(a) Natural sciences	79	324	1163	2416	3053	3500
	(b) Agricultural sciences	4	26	217	402	591	800
	(c) Engineering sciences	0	7	125	263	383	506
	(d) Medical sciences	0	0	9	42	49	60
	(e) All sciences	83	357	1514	3123	4076	4866

* Estimated

Table 2 - Total outturn of bachelors, masters and doctorate degree holders

Degree	Outturn (in thousands) for the year upto		
	1990	1995	2000*
Bachelors	2974	3657	4359
Masters	576	733	917
o Biological sciences		148	
o Chemical sciences	121	194	244
o Physical sciences	79	152	186
o Mathematical sciences	126	101	125
o Others	102	165	214
Doctorate	55	121	148
o Biological sciences	19	73	93
o Chemical sciences	17.6	26	35
o Physical sciences	8.0	22.8	28.5
o Mathematical sciences	5.5	10.3	12.9
o Others	4.9	7.0	8.6
		6.9	8.0

* Estimated

Table 3 - Approximate number of persons who obtained certificates, diplomas and degrees during 1950-1993

Subject	No. of persons (in lakh*) who obtained the qualifications upto					
	Higher secondary	Proficiency certificate	Bachelor degree (*)	Post graduate diploma	Masters degree	Doctorate degree
Natural sciences			34.5		6.7	0.64
Agricultural sciences			2.4		0.7	0.11
Engineering sciences			7.7	10.0	0.9	0.07
Medical sciences			3.8		1.0	0.01
Industrial trades		25.0				
Paramedical services				2.0		
Education			18.7		6.0	0.04
Law and Commerce			37.4		8.7	0.04
Arts			65.9		21.9	0.56
Others	350.0					
Total	350.0	25.0	170.4	12.0	45.9	1.47

(*) Attrition due to death has not been considered above and average life expectancy in the decades 1951-60, 71-80, and 81 has been estimated as 32.1,45.6, 51.6 and 60.2 y, respectively

(*) While the bachelors degree in natural sciences is earned after 3 y of education, that in agriculture, engineering and medical sciences (professional subjects) is earned after 4 y or more years of education. For the purpose of recruitment, bachelor degree in professional subjects is treated as equivalent to master degree in natural sciences

1950, 1960, 1970, 1980, 1990, and 2000 respectively, are presented.

Higher education has made great strides during 1950 to 1996. The out-turn of graduates in science and engineering was less than fifteen thousand in 1950 and it is expected to rise to about 2.8 lakh in the beginning of the twenty-first century. In 1990, out-turn of master degree holders increased 20-fold as compared to 1950. Fifty-fold more science and engineering doctorates got trained in 1990 as compared to that in the year 1950. During 1950-1995, over 94,000 persons earned doctorate degree. Of these, 73,000 did their doctorate in natural sciences (including 23,000 in chemistry, 26,000 in biology, 10,000 in physics, and 7,000 in mathematics). Besides, 12,000 persons obtained doctorate degree in agricultural sciences, 7,000 in engineering sciences and, 2,000 in medical sciences.

In terms of the current population and natural resources of the country, the number of persons who have received higher education in science and engineering subjects is rather small. The relative proportion of a doctorate degree holder to masters and bachelors degree holders, and the 10+2 certificate holders, for the entire 1950-1990 period, is estimated as 11, 55, 120 and 425, respectively. The fractions of persons in total population who obtained doctorate, master and bachelor degree in sciences in the year 1996 are estimated to be 7.8×10^{-6}, 7.9×10^{-5} and 3.0×10^{-4}, respectively (in the proportion 1:10:33). The available data further show that one person among about 10,000 living persons holds a PhD degree in various sciences. There are two persons holding bachelors, masters and/or doctorate degree in agriculture, engineering, and medical sciences and masters and/or doctorate degree in natural sciences for about 1000 living persons.

Table 4 shows that there has been all-round improvement in the education of women over the years. This is a reflection of betterment in the sociological environment in the country. The observed growth in participation of women in doctoral and postdoctoral education in the medical, engineering and agricultural sciences is much higher than expected. The rate of retention of women in scientific research is continuously improving on account of several remedial measures that have been taken, which include some relaxation in the age limit for the purposes of initial recruitment and suitable arrangement for maternity leave. There is quantitative improvement in the participation of women in seminars, symposia, and conferences and in their contributions in terms of research publications.

Table 4 - Female and male ratio of out-turn of S&T personnel (1990 and 1993)

Area	Degree/diploma	M/F ratio 1990	M/F ratio 1993
Science			
	PhD	4.1	3.8
	M Sc	2.1	1.8
	B Sc	2.8	2.9
Agriculture			
	M Sc (Agric)	11.0	9.8
	M V Sc	13.1	9.3
	B V Sc	16.5	6.7
	B Sc (Agric)	7.2	8.9
Engineering			
	PhD	20.7	11.7
	ME/MTech	11.9	9.0
	BE/B Tech	10.6	8.9
	P G Dip	9.2	6.3
Medical			
	PhD	6.4	6.4
	M.Ch/DM	15.6	2.3
	MD/MS	3.3	2.8
	P G Dip	2.4	1.4
	MBBS	1.5	1.4
	B D S	1.5	1.1

In recent years the rates of growth of higher education in several branches of sciences at bachelors, masters and doctorate levels have been progressively declining. The main reason for this situation is paucity of new jobs in sphere of science and technology. The latter, in turn, seems to be a consequence of continued poor uptake of trained scientists and engineers for R&D work by industry. The decline in the interest of fresh graduates to pursue higher education in science is alarming. India needs to emphasize on the programmes for the generation of manpower for R & D in science and engineering to meet its requirements of the future and to arrange facilities for the

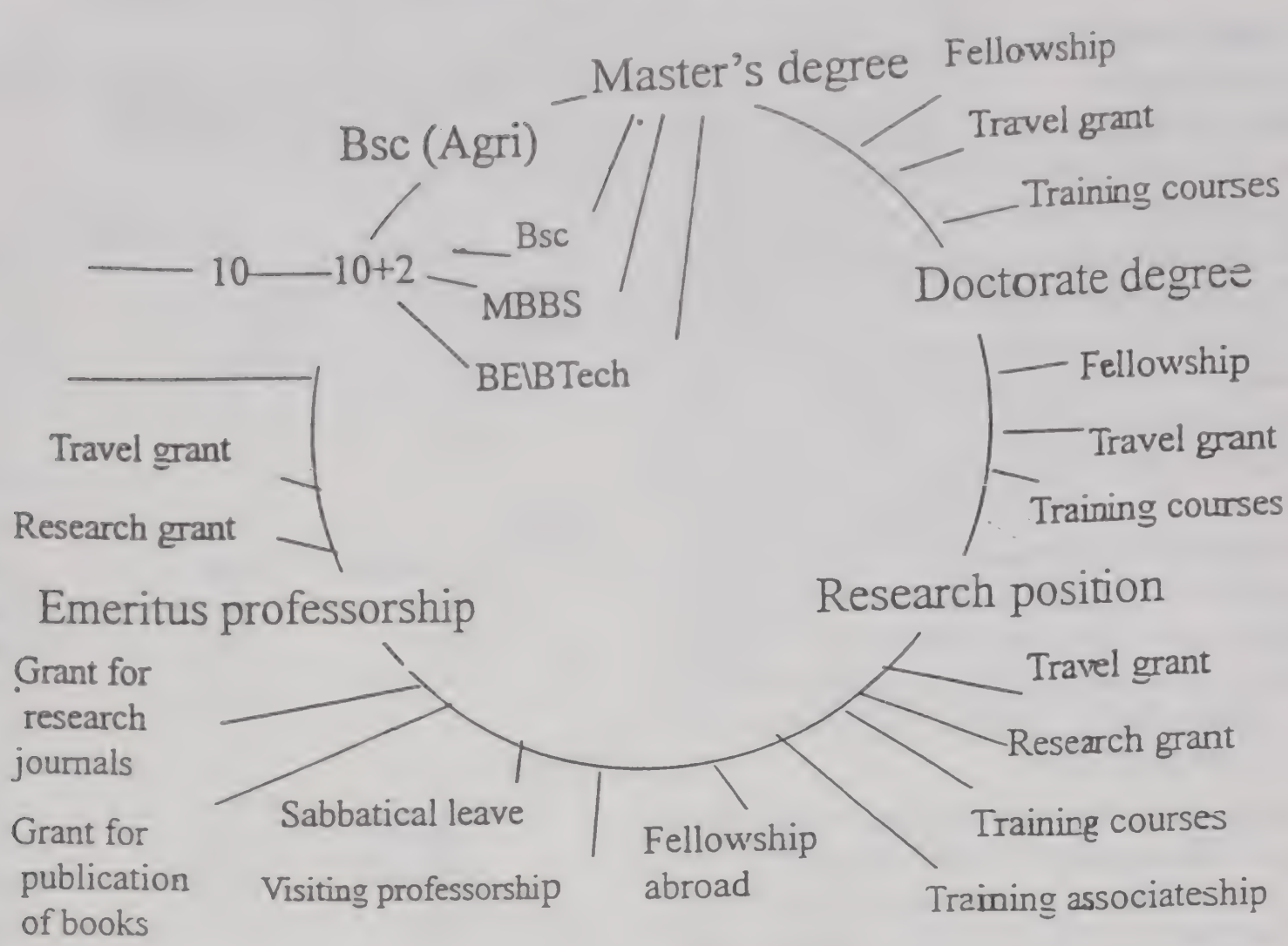

Fig. 4 — Outline of a typical scientific career in India. Opportunities available at different points of time in a scientist's career are indicated

upgradation of the skills and experiences of the scientists engaged in R & D at different levels.

3 Programmes for Improvement of Manpower Resources for R&D

Several schemes have been introduced for achieving this objective (Fig. 4). Some of these are discussed below.

(a) Research Fellowships, Research Associateships and Senior Research Associateships (Scientists Pool)

Science and mathematics are the integral part of school education up to class 10. About 25% of the students who pass the tenth class opt for science and related subjects at 10+2 level of their education.. Some of them proceed to obtain bachelors (45%) and masters (9%) degrees in the different branches of natural sciences, and engineering. In order to improve the retention rate of the students who have already expressed interest in science, agriculture, engineering, and medicine and to induce them to go for PhD degree or other higher qualifications, a large number of junior research fellowships (JRF) and senior research fellowships (SRF) are awarded by several agencies of the government. JRFs are selected through national eligibility test (NET) held nation- wide and SRFs are selected through direct interviews. The total tenure of JRF and SRF cannot exceed 5 y. Research Associateships (RAs) are offered to PhDs and equivalent post-graduate degree holders in science, engineering and medicine to encourage them to continue research in their respective areas. In the 90s, the number of fellowships awarded for doing PhD was the highest in the year 1991 when 2706 fellowships were awarded. Thereafter, there has been a continuous decline in the number of fellowships awarded, which is a direct consequence of the decrease in the number of applicants.

Senior Research Associateships (SRA), formerly called Pool Officerships, are offered to PhDs and equivalent degree holders with 2 y of postdoctoral experience so that they can continue to do their professional work while searching for regular positions. The tenure of SRA is 3 y. Till 1980, number of Indians trained abroad had been sizeable in the SRA scheme, but slowly their number is reducing considerably. During the last 5 y only 302 out of 900 persons

selected for the SRA were trained abroad. By 1995 a total of 19211 persons were selected as SRA, 14732 (76%) of whom were Indians trained abroad (40% of them were trained in the US). In science and agriculture subjects, maximum number (52%) were trained in the US, whereas in medical subjects, more than 70% were trained in the UK. It has also been observed that till 1996, maximum number of candidates selected under SRAship had obtained training in the US, the UK, Canada, and other European countries. The percentage of the candidates trained from Japan was hardly 2%, in 1991. But of the selections made in 1996, 16% of Indians trained abroad had been trained in Japan. In recent years, a large majority of SRAs are those who graduated from Research Associateship to this higher level of associateship.

The above programmes have been designed to give outstanding scholars 3 to 13 y of employment in research, free of any other commitments. About 65,000 research scholars have already benefited from these programmes. Out of this, 23, 374 persons had been awarded Fellowships and Associateships by CSIR from 1985 to 1995.

Table 5 gives the distribution of awards made by CSIR to research scholars in the Seventh and Eighth Five Year Plan periods from 1985-1996.

Travel Grants to Research Scholars and Scientists for Participation in the International Meetings

Often, Indian researchers receive information about latest findings in their areas of activity belatedly. This hampers generation of new ideas. In order to promote greater degree of originality in the work of Indian laboratories and for the overall improvement of manpower quality, CSIR, Department of Science and Technology (DST), and Indian National Science Academy (INSA) provide travel grants for the participation of PhD students, postdoctoral fellows, teachers, and research scientists in important international symposia, seminars, and conferences. These grants are awarded on the basis of academic and publication records of applicants. In the eighth Five Year Plan period from 1991 to 1996, about 2527 travel grants were sanctioned by CSIR, as is shown in Table 6.

Grants For Arranging Symposia/Seminar/ Conferences

Symposia, seminars, and conferences provide opportunities for scientific workers coming from different laboratories to interact, leading to cross fertilization of ideas and dissemination of information. Institutions such as CSIR, DST, Department of Biotechnology (DBT), Department of Ocean Development (DOD), and Indian National Science Academy (INSA) help scientific activity in the country by providing financial assistance for organisation of important national and international meetings. In the Eighth Five Year Plan, from 1991 to 1996, about 1306 meetings were supported by CSIR (Table 7).

Visiting Associateships

The Visiting Associateship Scheme aims at fostering creative science by joint teams of scientists from universities, industry, CSIR laboratories, and other government departments. It is hoped that the programme will lead

to collective efforts for rapid attainment of technology adoption goals and development of integrated policies in the areas of science and technology, education and environment. The Visiting Associates (VA) are provided facilities in CSIR laboratories for research work, travelling expenses, and accommodation for two visits of 30 d each year. The total tenure of a VA is 3 y. This scheme was started in 1989. In the years 1989-96, approximately 70 VAs benefitted by this scheme.

(e) Training Associateships

The Training Associateship Scheme is for supporting the scientists of CSIR to undergo specialized training for conducting collaborative research in specific laboratories of the government departments, university system, academic institutions or industry. The Training Associateship (TA) is for a period of six months to one year. The TAs are entitled to travel expenses, monthly stipend, and subsidized accommodation from the host institution. A contingency grant for each TA is paid to the host institution. This scheme was started in 1992. Surprisingly, only one person has availed this facility.

(f) Foreign Training

A majority of Indians go abroad for higher education in science and engineering and for research experience in frontier areas of S&T. Majority of such visits are arranged by individuals themselves through their personal contacts and correspondence. Accurate data on such visits sponsored by various agencies is not yet available. However, Table 8 gives number

Table5 – No. of persons awarded fellowships, associateships and pool officerships for the doctoral and post doctoral research by Council of Scientific and Industrial Research during 1985-1996

Year	Number of fellowships awarded for the						
	Doctoral work in the form of*			Post doctoral work in the form of*			
	JRF	SRF	Total (1)	RA	SRA	Total (2)	G.Total
(1)	(2)	(3)	(2+3 =4)	(5)	(6)	(5+6 =7)	(4+7=8)
1985	669	386	1055	184	294	478	1533
1986	640	467	1107	159	501	660	1767
1987	667	406	1073	168	420	588	1661
1988	680	573	1253	195	515	710	1963
1989	1041	256	1297	104	363	467	1764
1990	803	620	1423	350	377	727	2150
1991	1920	786	2706	453	302	755	3461
1992	1372	631	2003	423	140	563	2566
1993	1205	370	1575	270	154	424	1999
1994	1147	507	1654	491	220	711	2365
1995	1092	427	1519	442	184	626	2145
1996	890	398	1288	387	210	597	1885

(*) JRF : Junior Research Fellowship;
SRF : Senior Research Fellowship;
RA : Research Associateship;
SRA : Senior Research Associateship;

Doctoral research fellowships are awarded mainly by the Council of Scientific and Industrial Research (CSIR), University Grants Commission (UGC), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), Department of Atomic Energy, Department of Science and Technology (DST) and Department of Human Resource Development (DHRD) . Post doctoral research fellowships are awarded by CSIR, UGC, ICMR, DST, Department of Ocean Development and Department of Biotechnology. The data given above pertains to the awards given by CSIR. It is estimated that the awards given by other organisations combined may approach the figure shown for CSIR.

Table 6 — No. of research scholars and faculty members awarded grants by CSIR for attending International symposium /conferences during 1989 to 1996

Year	No. of persons supported
1989	200
1990	310
1991	397
1992	358
1993	339
1994	408
1995	490
1996	535
Total	3037

Table 7 — No. of symposia, seminars, conferences and workshops on science and engineering subjects held in India that were supported by CSIR during 1989 to 1996

Year	No. of meetings supported
1989	69
1990	90
1991	138
1992	170
1993	200
1994	207
1995	283
1996	308
Total	1465

of persons sponsored by the Government of India during 1985 to 1991 under its bilateral programmes for exchange of scientists with the governments of other countries throughout the world. CSIR sponsored 758 research scientists and engineers during 1992-1997.

(g) Provision For Leave Of Absence For Academic Work

R&D personnel working with the government or semi-government institutions are allowed study leave with full pay for a period of 2 y to acquire higher levels of education and research experience. They are also eligible for 5 y of extra-ordinary leave (i.e. without pay) which can also be availed of for academic work. In addition, the middle level R&D personnel can avail of up to 1 y long paid sabbatical leave every six years. The study, extraordinary and sabbatical leaves can all be availed of within or outside India.

Table 8 — No of Indian research scientists and engineers who received training abroad under the bilateral exchange programmes during 1965-1991

Year	Total
1985-86	196
1986-87	213
1987-88	209
1988-89	218
1989-90	286
1990-91	290
Total	1412

(h) Assistance from Non-resident Indians

Numerous scientists and engineers born and trained in India are settled abroad. Many of them possess expertise which is not available in the country. India is seeking their assistance in upgradation of skills of its R&D personnel. For this purpose, CSIR has initiated a new programme called Interface for Non- Resident Indian Scientists and Technologists (INRIST) from 1990. The ongoing UNDP-funded TOKTEN (Transfer of Knowledge Through Expatriate Nationals) project has been made a part of INRIST. A directory of NRIs giving biodata of about 2700 scientists and engineers has been prepared. Table 9 shows that about 2046 NRI scientists and engineers have registered themselves as possible consultants. Their visits are arranged in a phased manner under TOKTEN. About 513 consultants have already visited over 200 institutions/organisations in India under TOKTEN programme.

4 Discussion

The higher education and national economy are tightly linked because the S&T manpower through its R&D contributions advances the agricultural and industrial productivity of the country. The national strength at all the levels of education impinges on the

Table 9 - Transfer of knowledge through expatriate nationals (TOKTEN) visiting scheme of United Nations Development Programme

Location of non-resident Indians	No. of scientists and engineers who have registered as possible consultants	No. of consultants who have so far visited India
Asia and Oceania	44	8
Africa and Middle East	17	2
Europe	122	32
North and South America and Canada	1863	471
Total	2046	513

quality and quantity of S&T manpower. There is a need to strengthen the primary and secondary education since the dropout rates at the primary, middle and secondary school level are in the range of 37, 53 and 71%, respectively. Out of which, 4.5 persons per thousand are receiving higher education. From among these, less than one per cent opt for the doctoral and post doctoral programmes. All the funding agencies of the government and industry concerned with S&T must support education at all the levels, especially at the post graduate and higher levels, in the short-term and long-term interest of the industrial and economic growth. This requirement is urgent in view of the decreasing trend in the outturns, considering the persistent growth of population.

How must then India improve the quality and quantity of higher educated people in the sciences?: (i) The growth of opportunities for higher education in S&T subjects in the university system has not been realized in recent years largely because of the limitations in the funding for more colleges and universities. The teaching staff in the universities is greying in view of the poor turnover. Therefore, the facilities available in the R&D laboratories of the government departments, such as those of the DSIR, DST, DBT, DAE, DARE, and DRDO must be used for the training of the students. These laboratories and the eminent staff there may be recognized by the university system as the centres for higher education and the faculty of their sciences and engineering departments, respectively; (ii) The schemes of the kinds described here for training and retraining of the existing staff in the university and the government R&D laboratory system must be enlarged and strengthened to improve the all round productivity of the staff through acquirement of some new skills by retraining, new ideas by discussions and perspective information through networks; (iii) The government should not continue to be the only agency for funding the higher education and research in the different disciplines of science and engineering. With increase in the costs, it has become essential that the private organisations and industry now come forward to generate resources for the education, research, and employment in the S&T areas. A bridge between universities, laboratories and industry has to be built and buttressed for India to become a technology advanced nation.

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Projections for Transport Sector in India

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An attempt has been made here to project the future developments in transport sector in India with the help of mathematical modelling techniques. Bass model has been used to study the diffusion of cars, motorcycles and scooters and Fisher- Pry model to analyse the cases of technology substitution for the items like railway electrification, locomotives, goods and passenger traffic by road/railway and surfaced roads. Social, economic and technological factors, which play a major role in the process of diffusion/substitution along with policy issues have also been discussed.

Introduction

Transport sector has tremendous impact on the economic and social development of a country. With the ongoing liberalization of Indian economy transport sector and automobile industry have been opened for private investment and are receiving good response from foreign vehicle manufacturers and other concerned business groups. Several studies by various agencies have been conducted to assess the market potential of automobiles in India using different techniques and tools. Here an attempt is being made to analyse the future growth prospects of automobile sector in India with the help of quantitative techniques of mathematical modelling. Fisher - Pry model has been used to study the competition among competing technologies viz. electrified/non- electrified railway routes, steam/ diesel/ electric locomotives, goods and passenger traffic by road and railways and surfaced/unsurfaced road. The findings present various scenarios which may be useful in future planning and taking decisions for launching a new product in the market, making right kind of investments in the right technology at the right time and pricing of the product as it influences the potential adopters.

Methodology

The study is mainly based on quantitative techniques of mathematical modelling viz. diffusion models and substitution models. Researchers and market analysts have found these models to be very useful for making market forecasts. These models are already well known[1-5].

Diffusion Models

The Bass[1] diffusion model, which is frequently used to study the diffusion of products and technologies, is expressed mathematically in the following form:

$$dN/dt = (p + qN/M)\,[M-N], \qquad ...(1)$$

which on integration yields

$$N(t) = M\left[\frac{1 - \exp[-(p+q)t]}{1 + [(q/p)\exp(-(p+q)\,t)]}\right] \qquad ...(2)$$

Here, $N(t)$ is the cumulative number of adopters at time t. The model assumes that in the conversion factor, $[p+(q/M)N]$, the parameter p represents external influence and q internal influence and M is the upper limit of potential adopters.

Substitution Model

The diffusion of technology can also be viewed as an evolutionary process of replacement of an old technology by a newer one for accomplishing similar objectives or doing similar jobs. Here, Fisher-Pry model[6], which describes substitution phenomenon

very well, has been used to project the share of electrified railway route, surfaced road, goods and passenger traffic by road and electric and diesel locomotives. The model may be expressed as follows:

$$(1/f)\, df/dt = 2k\,(1-f), \qquad ...(3)$$

where f is the fractional substitution and $2k$ is the annual growth rate.

Integrating equation (3), we get

$$\ln [f/(1-f)] = 2kt + c, \qquad ...(4)$$

where c is the constant of integration.

Literature on technology substitution is full of mathematical models which are used to model product substitution. The inherent assumption in these models is that an old technology is completely replaced by new technology. In many cases more than one competing technologies coexist at the same time,e.g. energy (coal-oil-hydel) and locomotives (steam-diesel-electric) and multiple substitutions take place.

Applications

Bass model and Fisher-Pry model are used here to develop the future scenarios for the transport sector in India. Bass diffusion model is used to estimate the future demand of cars, scooters and motorcycles. This is an extension of author's earlier work[3,7] to check the results with the actual performance. Items selected for the study may be put in two categories: (i) products whose growth may be described with the help of Bass diffusion model and (ii) whose spread can be explained with the help of substitution models.

In the first category, production data[8] for three products viz. cars, scooters and motorcycles (Fig. 1) for the period 1971-96 have been taken. This data has been used to estimate the parameters p, q and M of Bass model with the help of SYSTAT[9] package. Using Eq. (2) and the values of the parameters p, q and M, which are given in Table 1, projections for production of each item have been made up to 2005 AD.

Similarly substitution model as proposed by Fisher-Pry[6] has been used to study the developments where old product/technology is being replaced by a new one. Railway electrification, goods and passenger traffic (road for railways), surfaced road and railway locomotives are included as case studies.

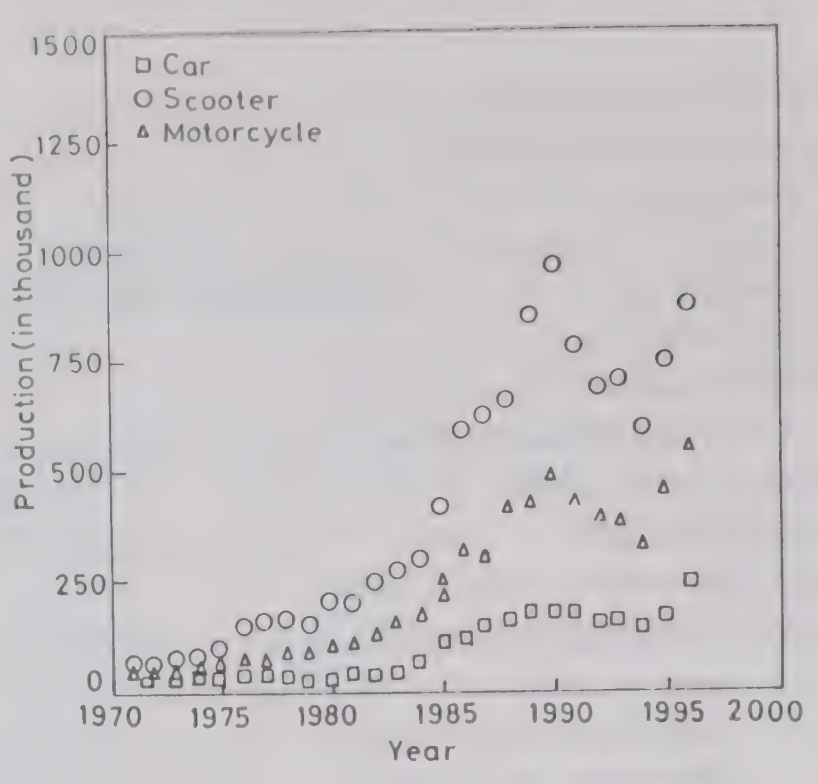

Fig. 1 — Production of passenger vehicles

Table 1 — Parameter estimates for Bass Model

Products	Parameters			
	p	q	M (million)	
			Present	Old
1 Cars	0.002	0.118	6.35	2.7
2 Scooters	0.001	0.223	14.32	7.6
3 Motorcycles	0.002	0.198	8.99	4.7

Assuming that electric and diesel locomotives both are replacing steam locos, its share in the market (f) has been calculated and then plotting log $[f/(1-f)]$ vs time, we observe that it gives a linear trend (Fig. 2). From this we can project its share (f) in the future. Similarly the shares of surfaced roads, goods and passenger traffic (road for railway) and electrified railway routes have been estimated. Parameter estimates are given in Table 2 and there future shares are given in Table 3. The results are also shown in Figs 2-6.

Results and Analysis

With the liberalization of Indian economy many well known foreign vehicle manufacturers including Ford, Mercedes Benz, BMW, General Motors, and others have decided to make India a base to produce world-class vehicles. Besides feasibility studies by

Table 2 — Parameter estimates

Items	Parameters	
	a	*b*
1 Railway electrification	- 5.740	0.851
2 Surfaced roads	0.591	0.108
3 Railway locomotives	- 4.698	0.130
4 Goods traffic Road/Railway	- 0.899	0.061
5 Passenger traffic Road/Railway	0.14	0.071

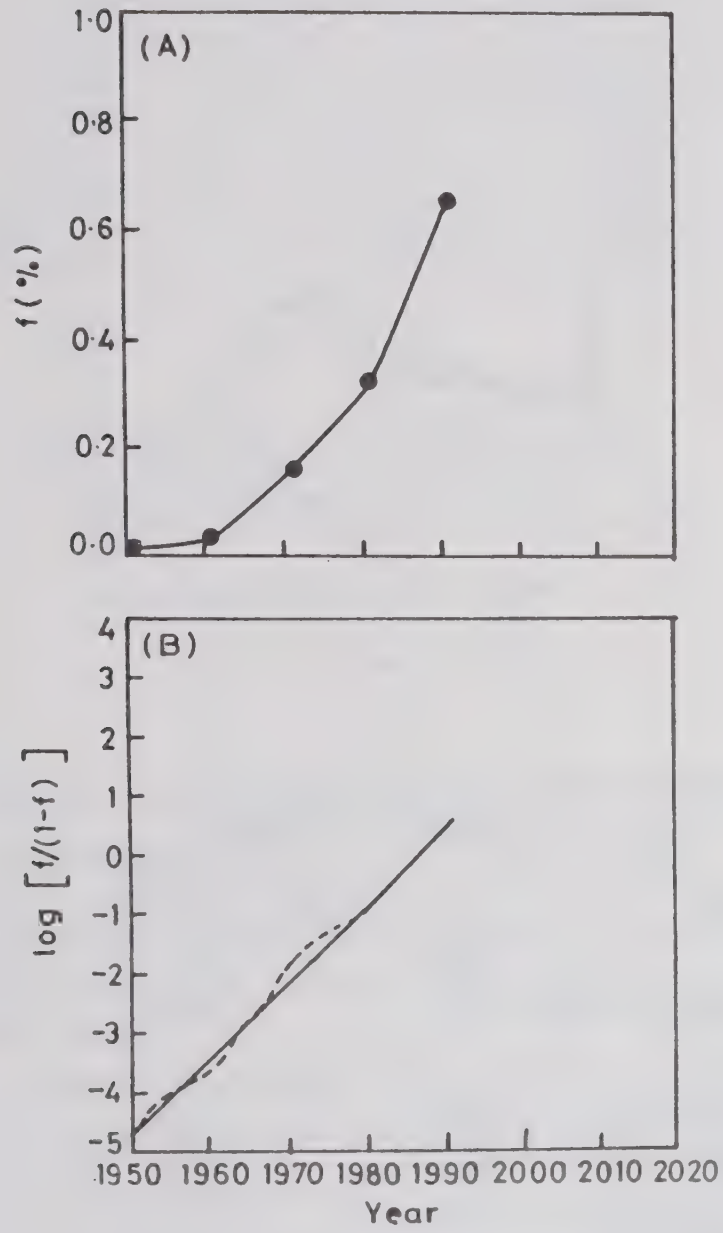

Fig. 2 — Share of electric and diesel locos

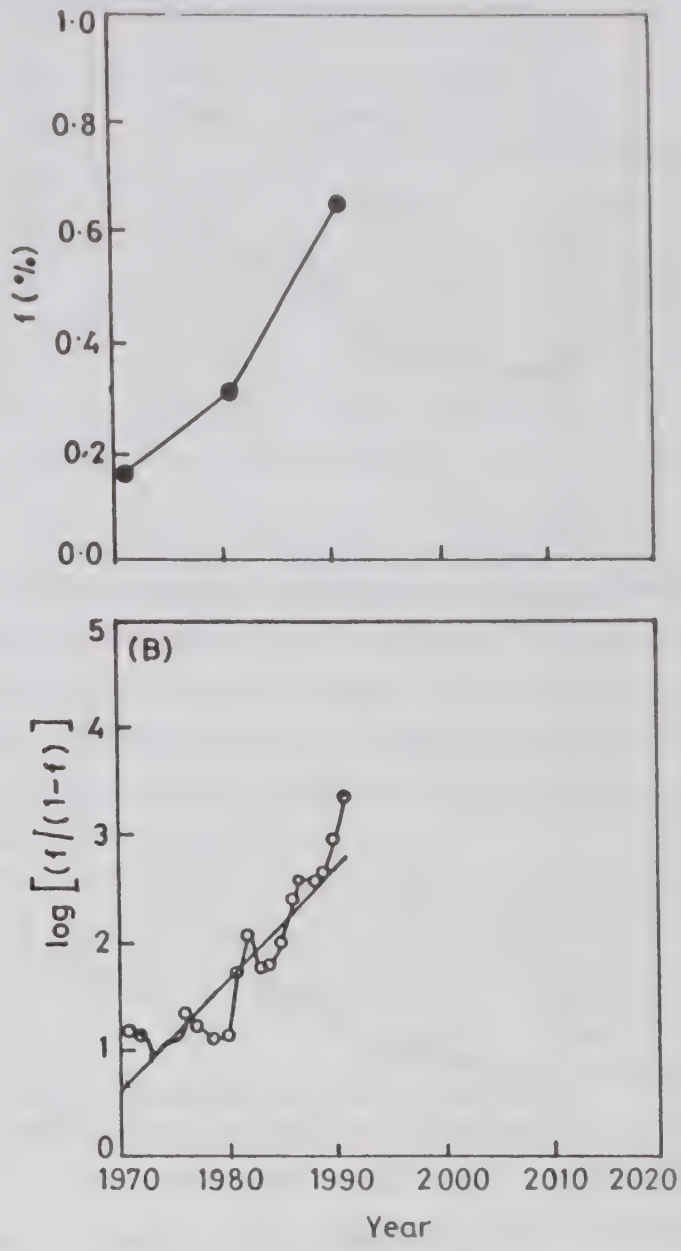

Fig. 3 — Share of surfaced roads

these corporations many independent bodies have done market research to determine the future demand of different kinds of vehicles in India. These projections range from 4 M to 8 M for the year 2000 A D[11].

The demand for cars by the year 2000 AD is estimated to be in the range of 7 to 17 lakh, 8.33 lakh being the most likely scenario. Besides other factors, these estimates are based on a NCAER survey that by the year 2000 AD there will be four million households in the category of very rich and the annual PCI will be more than or equal to $1290 (World Bank Estimate[10]). For two- wheelers, which is growing at breakneck speed, industry analysts have projected the demand of 4 M by the year 2000 AD.

The projections based on mathematical models for technology diffusion in the case of cars, motorcycles and scooters show a declining trend in annual sale. This may be because of static market potential (*M*), which is fixed for every data set in the beginning of

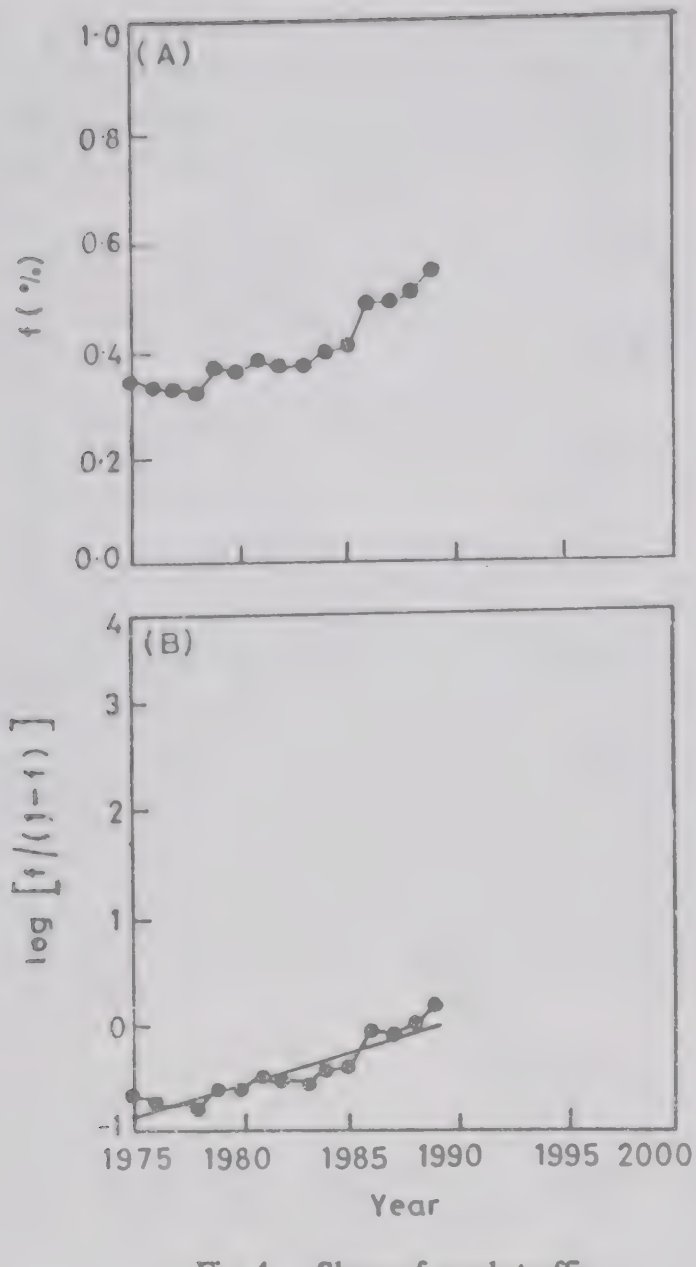

Fig. 4 — Share of goods traffic

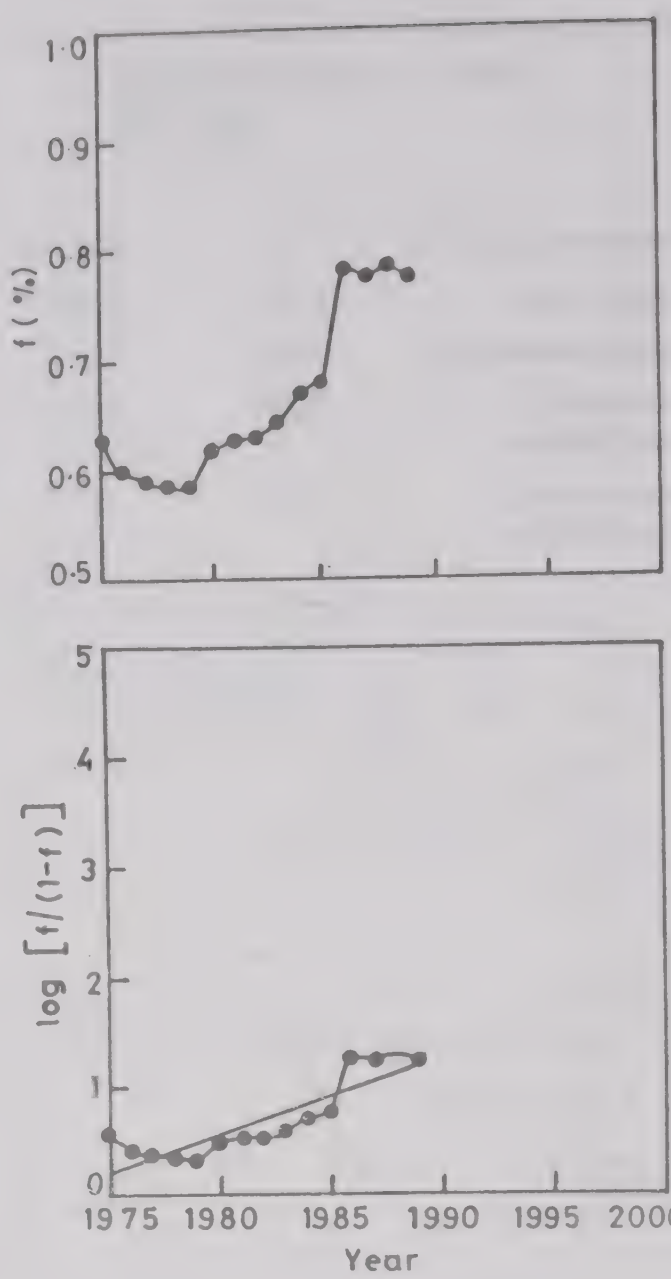

Fig. 5 — Share of passenger traffic

the diffusion process. The estimates are not realistic as the production has been consistently increasing every year since 1994. The potential market (M) is estimated to be 6.35 M, where as the same in the earlier study was estimated to be 2.73 M. It has more than doubled in the last five years. This may be an indication of the emergence of a new phase of diffusion of cars, which is also evident from Fig 1. The coefficient of imitation (q), which greatly influences the rate of diffusion, is 0.118 which is very large in comparison to the earlier value of 0.005. However, the estimates of annual sales obtained by using Bass diffusion model do not show any increase in the sales. These estimates are lower than the actual performance and indicate that the dynamics of growth is not fully captured by the model. To make the forecasts more realistic a few other well known models, viz. logistic and exponential, have also been used in all

Table 3 — Projections

Unit:Per cent

Item	Year	
	2001	2011
Railway electrification	34.66	55.40
Locomotives	87.35	96.20
Surfaced road	98.09	99.34
Goods traffic Road/Railway	67.87	79.54
Passenger traffic Road/Railway	88.67	94.09

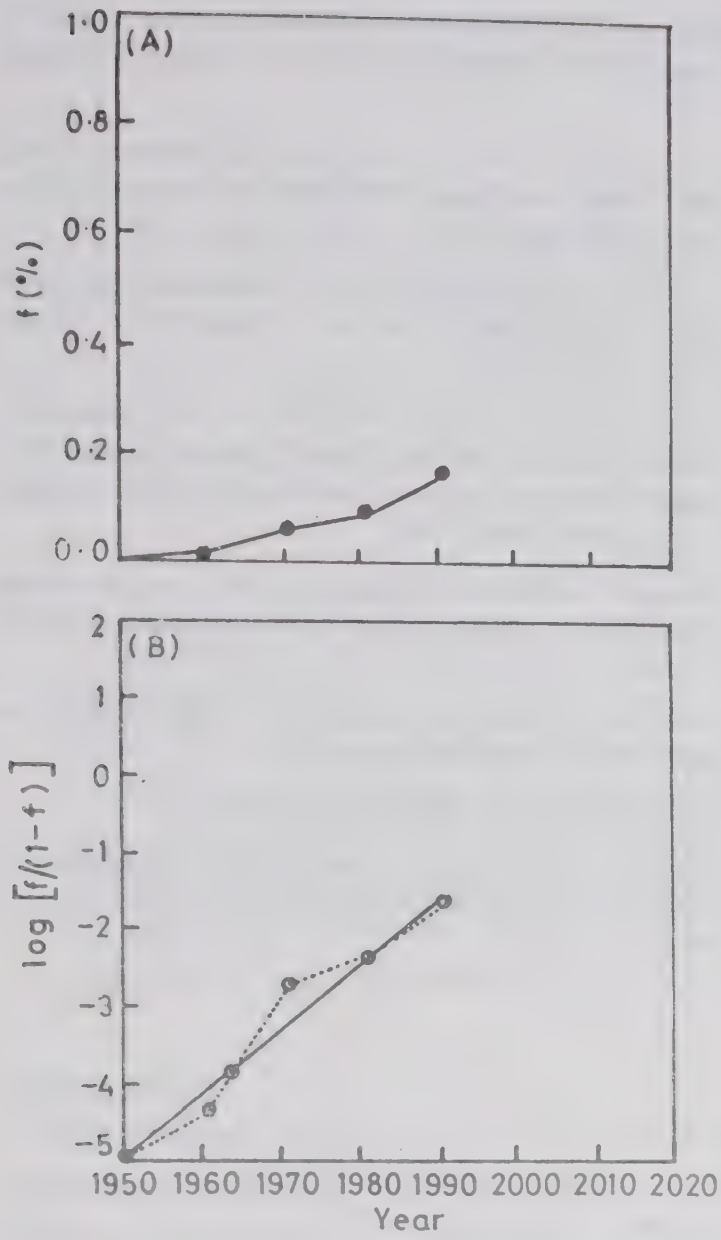

Fig. 6 — Railway electrification

the three cases. Logistic model predicts a slower growth rate in comparison to exponential model. In Table 4 projections of annual production for cars, scooters and motorcycles as obtained by different models are given, the upper limit being the most likely case.

It may be noticed from Table 1 that the upper limit of the potential market (*M*) has an increasing trend, i.e. it is increasing with time for all the items. This is also confirmed by a survey report of NCAER[10], which had earlier estimated the number of very rich households in India at two million and recently updated it to four million. This implies a gradual increment in the number of buyers from time-to-time. For a developing country like India, where GDP and per capita income both are increasing, the potential market or the buying power of consumers has to move only in upward direction. Thus the future prospects

Table 4 — Future projections

Unit:Thousands

Year	Cars	Scooters	Motorcycles
1998	244-504	911-976	568-628
1999	261-655	960-1038	590-669
2000	279-851	1008-1104	608-712
2005	381-3155	1212-1506	639-975

of automobile industry are bright as the population is slowly moving from poor to rich to very rich groups, which in turn implies a larger potential market. The model results also show a similar trend as the total potential market has more than doubled in each case (Table 1) in the past five years.

From the results it is evident that the market is growing and demand is picking up for all the products from 1994 onwards (Fig 1). It seems that the depression period is over, e.g. in the case of cars production has gone up from 3.46 lakh in 1995-96 to more than 4 lakh in 1996-97. The future of automobile industry in India looks to be very bright as potential market and PCI are increasing and prices of the products are coming down because of competition, surplus supply (according to some experts) and improved productivity. The present growth pattern is only an indicator of the emergence of a new phase of diffusion, which can also be noticed in Fig.1.

In the case of technology substitutions it is projected that 34.66% and 55.40% of the railway routes will be electrified by the years 2001 and 2011 AD, respectively. Trends show that steam engines will be almost replaced by electric and diesel locomotives by the year 2001 AD. In the case of roads it may be noticed that the growth of surfaced roads follows the growth of unsurfaced roads and both are growing alternatively. The estimate of the share of road transport by other agencies[11] in the case of passengers and goods is put to be around 92 and 80 per cent, respectively for the year 2000 AD, where as corresponding estimates of this study are 88 and 68 per cent, respectively. The fractional shares and Fisher-Pry fits are presented in Figs 2-6 for all the five-items and the results are given in Table 3.

Concluding Remarks

From the above analysis it may be concluded that transport sector requires more investments to meet the growing demands of the increasing population, to provide better facilities and world- class services. Funds have already started flowing in automobile sector, but infrastructure sector, in general, and railway electrification and road developments, in particular have to be taken care of to meet the future demands. The quality, size and number of roads greatly influence the vehicular growth and at present these are inadequate.

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Production of Biosurfactant from Sugar Alcohols and Natural Triglycerides by *Aspergillus terreus* Lipase

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Lipase from *Aspergillus terreus* catalyzes trans- esterification between sugar alcohols (sorbitol, mannitol, and xylitol) and various oils in dry pyridine. The product is a primary monoester of sugar alcohol and fatty acid. The results reveal that all the seven oils and pig fat could be converted to their respective sugar monoesters. The highest yield of monoester was obtained with coconut oil (0.75 g) followed by sunflower oil, and pig fat. The same reaction was also performed between coconut oil and sorbitol or mannitol or xylitol in pyridine or toluene or acetone. The maximum yield of monoester was obtained with sorbitol in pyridine. The monoester produced has excellent surfactant properties in terms of its ability to reduce interfacial and surface tension. This monoester also stabilizes the water-xylene emulsion.

Introduction

The potential applications of microbial lipases have been the subject of several recent reviews [1-6]. Lipases find immense use in organic synthesis because of low costs, stability in organic solvents, wide versatility, easy use, and non-requirement of added cofactors[7]. Fatty acid esters of sugars and sugar alcohols are nonionic surfactants with important applications in many areas, particularly enhanced oil recovery, environmental detoxification processes; and detergent, food, cosmetic, agricultural, and pharmaceutical industries[8,9]. These biosurfactants have interesting surface active properties due to their composition and have very good emulsifying, stabilizing or conditioning effects. In addition to being the conjugates of renewable feed stocks, inexpensive and readily available, they are environment-friendly because these are completely biodegradable under aerobic and anaerobic conditions. The biosurfactants are nontoxic, non-skin irritants, odorless, and tasteless[10,11].

Biosurfactants are generally obtained either by chemical processes[12] or from microbes[13]. However, biosurfactants produced by microbes cannot be subject to any chemical modification as their characteristics are genetically determined[12]. Further, the purification processes are expensive. On the other hand, chemically produced surfactants have the disadvantages of being toxic and generally nondegradable and their production processes involve high temperatures which cause coloration of the final products as well as dehydration and cyclization in the case of sugar alcohols. The use of biological catalysts (enzyme) under mild conditions for the synthesis of esters of sugars or sugar alcohols can overcome this problem and enzymic approaches have been developed in the recent years[14-19].

However, there is still a continuous search for enzymatic synthesis of biosurfactants using economically cheap substrates and enzymes. The present work describes the synthesis of a biosurfactant by *Aspergillus terreus* lipase.

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Enzyme Production

Czapek Dox minimal medium broth containing 1.5 per cent v/v pig fat and 0.2 per cent glucose was used for lipase production. 5 x 10^7 conidia/50 ml were seeded and incubated at 37 ± 1°C for 72h. Crude enzyme was purified by ammonium sulphate precipitation (85 per cent saturation), desalted by

dialysis and subjected to acetone precipitation (25 per cent and 35 per cent). The enzyme sample was then purified using successive chromatographic separation on Sephadex G-100 and Q-Sepharose. The purified enzyme was then lyophilized.

Trans-esterification

Sorbitol, 3g and seven oils and pig fat, 7.5 ml were dissolved in 50 ml pyridine. *A. terreus* lipase was added to this mixture to give a final concentration of 200 mg/50 ml. The reaction was carried out for 72 h under shake conditions. The product obtained was compared with standard sorbitan mono-oleate on thin layer chromatographic plates (Silica gel G-25; Merck). This product was then isolated and purified by column chromatography using silica gel G-50 (Merck).

Similar trans-esterification studies were also performed using coconut oil (highest biosurfactant production supporter) and sorbitol in toluene and acetone. Further, trans-esterification experiments were also carried out between coconut oil and mannitol and xylitol in pyridine, acetone and toluene. The monoesters formed in all the cases were isolated and purified.

Surfactant Properties

The surfactant potential of the sugar alcohol esters thus obtained was evaluated by : (i) Reduction of interfacial tension, (ii) Reduction of surface tension by the 'du Nouy ring method' using a Fisher surface tensiometer[13], and (iii) The stability of the water-in-xylene emulsion[13].

Results and Discussion

Trans-esterification carried out by *A. terreus* lipase between seven oils and pig fat and the sugar alcohol, sorbitol in pyridine, resulted in synthesis of sugar monoesters (Fig. 1). The monoesters have the properties of causing reduction of interfacial tension and surface tension. They also stabilize water-in-xylene emulsion. The authors' finding is in accordance with the report on the catalytic power of trans-esterification of the lipase from *Chromobacterium viscosum*[13]. However, *A. terreus* lipase is the first fungal lipase that shows this type of trans- esterification reaction in organic solvents. This finding is contrary to that of Chopineau *et al*[13]. where they have reported that trans-esterification reaction for the synthesis of a biosurfactant could be carried out only by porcine pancreatic lipase and *Chromobacterium viscosum* lipase, while all the other lipases from *Pseudomonas* sp., *Aspergillus niger, Rhizopus oryzae, R. niveus, Mucor* sp., and *Candida cylindracea* failed to carry out trans-esterification[10,13,19]. Moreover, the yield of monoester is about two-fold higher than that obtained with lipase from *Chromobacterium viscosum*[13]. Hence, the present report of *A. terreus* lipase being the first of its kind is significant and could be further exploited for industrial processes in various areas of biosurfactant synthesis.

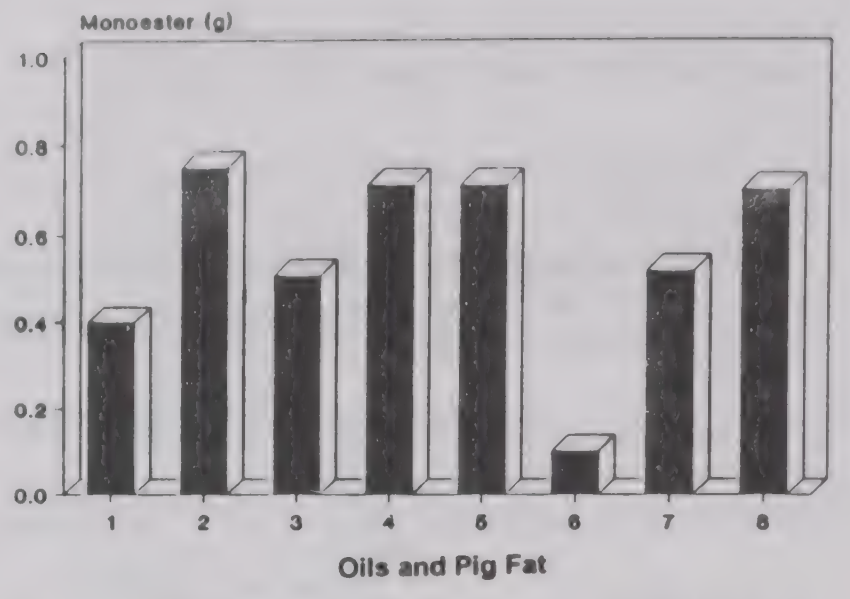

Fig. 1 — Trans-esterification between seven oils and pig fat and sorbitol in pyridine (1 - Olive, 2 - Coconut, 3 - Mustard, 4 - Sunflower, 5 - Karanja, 6 - Kusum, 7 - Neem, 8 - Pig fat

In the present investigation, the highest yield of monoester was obtained with coconut oil (0.75 g) followed by sunflower oil, karanja oil, and pig fat. Thus, the yield of monoester depends on the composition of the oil used. This is in contrast to the report of Chopineau *et al.*[13], who reported that the composition of the oils does not dramatically affect the yield of sorbitol monoester. The tropical climate of India favours the growth of several unique trees such as the neem, kusum and karanja. Oils produced from the seeds of these trees are cheaply available locally in reasonable quantity. The authors have successfully made use of these Indian non-conventional oils for trans- esterification reactions in organic media. Hence, this report is of much economic value from the viewpoint of Indian industry.

Extending the experiment, the same reaction was also performed between coconut oil and sorbitol, mannitol, and xylitol in various organic solvents such

Table 1 — Acylation of various sugar alcohols and coconut oil in various organic solvents

Organic solvent	Monoester, g		
	Pyridine	Toluene	Acetone
Sorbitol	0.71	0.62	0.68
Mannitol	0.46	0.42	0.36
Xylitol	0.32	0.30	0.28

as pyridine, toluene, and acetone (Table 1). The results showed that in all the experiments, there was trans-esterification and maximum product was obtained with sorbitol in pyridine, followed by mannitol and xylitol. Among all the sugar alcohols tested, sorbitol gave maximum yield of monoester in all the organic solvents tested. Further, experiments done by the authors with pyridine, toluene, and acetone have shown comparable yields of monoester. Thus, the results demonstrate that the industrially non-compatible solvent[10,19] pyridine, used in other investigations[13], can be replaced with commonly used solvents such as acetone and toluene, which are routinely used for various industrial processes and are easily available. The results suggest that the hydrophobicity of organic solvents has great bearing on trans-esterification. It has earlier been suggested that lipase catalyzed trans- esterification reactions take place at low water activity levels[1]. Our findings are also in accordance with the report of *Candida cylindracea* lipase catalyzed trans-esterification reaction of ethylpropionate which was 48-times higher with methanol than heptanol, but only 2.2-times higher in the case of water saturated substrates[18]. The results also explain the absolute necessity of polarity of every substrate, because of its ability to modify the water partition between the solid phase (enzyme preparation) and liquid phase (substrate and product). This results in drastic changes in enzyme activity as has also been reported in the case of *Candida cylindracea* lipase[18].

The results presented in Tables 2-4, show that the enzymatically prepared surfactant was more efficient than the chemically prepared one. This is most likely due to greater hydrophobicity of sorbitol mono-oleate as compared to sorbitan mono-oleate and consequently more hydrophilic-lipophilic balance (HLB). Similar results have also been found with *Chromobacterium viscosum* and pancreatic lipases[13]. The authors' results, thus clearly establish the fact that the hydrophobicity of organic solvents and the nature of triglycerides have great bearing on trans-esterification reactions. In addition, the experiments

Table 2 — Comparison of interfacial tension between xylene and water afforded by chemically and enzymatically prepared surfactants (using *A.terreus* lipase)

	Interfacial tension (dynes/cm)		
	Concentration, %		
Surfactant	0.000	0.005	0.010
Sorbitan mono-oleate (commercial)	40	30	24
Sorbitol mono-oleate (enzymatically synthesized)	41	11	5

Table 3 — Reduction of surface tension of dimethyl formamide by chemically and enzymatically prepared surfactants (by *A.terreus* lipase)

Surfactant	Surface tension, dynes/cm						
	Concentration, %						
	0.0	0.1	0.2	0.3	0.4	0.5	1
Sorbitan monooleate	32	32	31	31	31	31	31
Sorbitol monooleate	32	33	31	30	29	22	18

Table 4 — Comparison of stabilization of water-in-xylene emulsions afforded by chemically and enzymatically prepared surfactants (Using *A.terreus* lipase)

Water-in-xylene emulsion	Separation, %						
	Reaction time, h						
	1	2	4	5	6	7	8
Control	100	100	100	100	100	100	100
Sorbitan mono-oleate	30	45	55	60	64	65	65
Sorbitol mono-oleate	7	10	13	16	18	21	21

with the *A.terreus* lipase have found the enzyme to be highly thermostable showing optimum lipolysis at 50°C and retaining 100 per cent activity at 60°C for 24h and at 70°C for 15 min.[7,20]. The thermal kinetics of this enzyme thus make it an ideal candidate for carrying out various bio-organic reactions at the industrial level. Hence, the results clearly emphasize the fact that a fungal lipase can also mediate transesterification between sugar alcohols and triglycerides in a manner similar to and reported so far only by *Chromobacterium viscosum* and porcine pancreatic lipases.

Conclusions

A.terreus lipase is the first fungal lipase with the ability to synthesize biosurfactants from sugar alcohols and natural triglycerides in conventional solvents like acetone and toluene besides pyridine. The biosurfactants (sugar monoesters) produced have efficient surfactant properties such as the ability to reduce interfacial and surface tension and stabilize water-xylene emulsion and can be made use of in various detergents, food, cosmetic, agricultural and pharmaceutical industries.

Acknowledgements

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The Changes Observed in Viscosities and Conductivities of Bentonite Sludge Samples Prepared in Different Concentrations by Volume Upon the Addition of Salts and Polymers

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The rheological properties and conductivities of three different bentonite clay sludges in varying concentrations by volume have been determined. The KCl salt and $(NaPO_3)_n$ polymer which were added to samples of the sludge in seven different concentrations had different effects on the viscosity, yield point and conductivity values. These differences observed were related to different ways in which the salt and the polymer interact with the negatively charged clay particles. The results show that the η_a and τ_y values are directly related to concentration by volume of the clay in the sludge and inversely related to the conductivity values. The effect of KCl on the viscosities of the three different sludge samples with varying concentration is similar. The $(NaPO_3)_n$ polymer, contrary to KCl salt, reduces the rheological values of the sludges. In the use of the bentonite clay sludges in industry, the addition of the $(NaPO_3)_n$ polymer is recommended whenever an decrease in the viscosity of the sludge is necessary; and the addition of KCl salt is recommended if an increase in viscosity is desired.

Introduction

Montmorillonite minerals are among the most interesting members of the family of clay minerals because of their characteristic properties. The particularly small size of the particles provides for larger surface areas and, thus, greatly increases their adsorption capacity. Moreover, the colloidal or gel-like structure in water, plasticity, rheological and electrokinetic properties of these minerals are all of great interest[1]. Today, they are used in different branches of industry such as in drilling fluids, dyes, pharmaceuticals, paper, cement, and ceramics. The kind and the abundance of the exchangeable cations among the unit cells; as well as their crystalline structure give rise to a wide range of usage for these minerals.

The unit cell of montmorillonite is between an octahedral sheet of Al-O-OH and two tetrahedral sheets of Si-O. However, sometimes the tetravalent Si in the tetrahedral sheet is replaced by the trivalent Al atom; and the trivalent Al in the octahedral sheet is replaced by the divalent Fe or Mg ions. The deficiency in positive charge or the excess in negative charge which result from this isomorphous exchange are balanced by the cations adsorbed among the layers or at the fractured edges. The kind and the abundance of these cations determine the water adsorptivity, the electrokinetic, rheological and all other properties associated with montmorillonite clays, as well as their use in different areas of industry. Presently, the basic clay mineral is called montmorillonite and the clays of the smectite group derived from montmorillonite which contain other clay minerals are called bentonites[2-5].

The literature contains various publications on the rheological properties of bentonite clays. These publications are concerned with the effects of such factors as the pH, the concentration by volume, the internal structure, the presence of exchangeable cations and the particle size on the rheological properties of bentonite sludges[6-17].

The main purpose of this study is to determine the rheological properties and the conductivity of a non-swelling bentonite-water system as a function of

increasing bentonite concentration. Another purpose of the work is to study the effects of the addition of KCl salt and the $(NaPO_3)_n$ polymer, in seven different concentrations, to sludges having various concentrations by volume.

Experimental Procedure

The non-swelling bentonite sample was obtained from the Cankiri area in Turkey (Filiz Madencilik AS) They have been sieved with the 44 μm (325 mesh) spaced sieves. Mineralogical analysis of the bentonite showed that it contained smectite, and quartz and calcite impurities. The sample had the chemical composition (%): SiO_2 63.55; Al_2O_3 16.58; Fe_2O_3 5.45; CaO 1.74; MgO 2.53;Na_2O 2.00; K_2O 0.89; TiO_2 0.72.

The different sludge samples having concentrations of 6.88 and 11.4 by volume (v/v) were prepared from this non-swelling bentonite. The viscosity of each sludge sample was determined using a Fann type viscosimeter with a rotating drum (Baroid, model 35 SA).

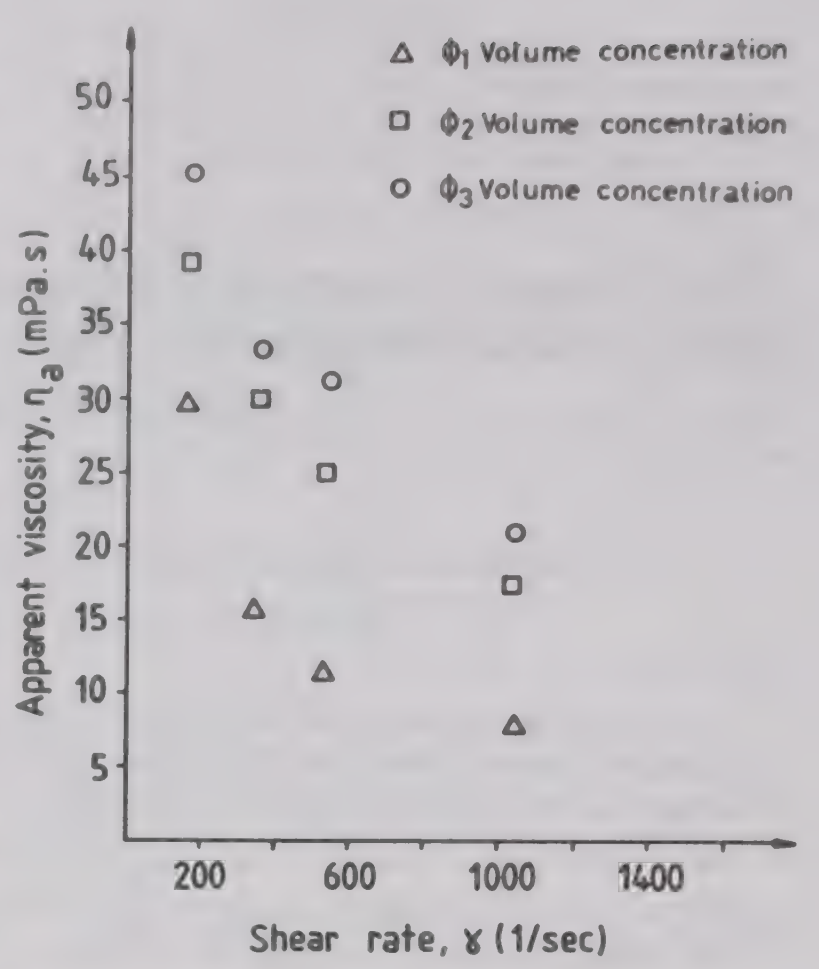

Fig. 1 — Apparent viscosity vs shear rate

Results and Discussion

Solid-water systems can be divided into two main groups as "gelled" and "fluid" based on their rheological behavior. Although there is no change in viscosity with shear rate in fluid media, the gelled structures (generally the clay-water systems have a gelled structure) show a plastic-like fluid behavior.

The viscosity of a bentonite-water system is related to the interactions between the particles of the system. The bentonite particles with a net negative charge interact with each other through Coulombic and van der Waals forces. As a result of these interactions EE(Edge-to-Edge), EF(Edge-to-Face) and FF (Face-to-Face)combinations may be obtained. The concentration by volume(bentonite/water ratio) and shear stress will be effective on these combinations. The viscosity of system

$\eta = f(\phi, \tau)$,

where ϕ is the volume concentration (volume fraction), $\tau_r = \tau a^3/kT$ is a dimensionless shear stress, τ is the actual shear stress, a is the particle radius, k is Boltzmann's constant, and T is the absolute temperature[18-20]. Figure 1 gives $\eta_a = f(\dot{\gamma})$ the curves for the sample at different concentrations by volume. The decrease in η_a values with increasing shear rates indicates that these sludges have thixotropic property at all concentrations by volume. The thixotropic property increases with increasing concentration by volume. The change is minimum when the concentration by volume is low. The $\tau = f(\dot{\gamma})$ curves given in Fig. 2 show that at all three different concentrations by volume the flow model conforms to the Bingham plastic flow model.The required shear stress values for fluid systems have been calculated both from this graph by extrapolation and from the $\tau_y = \phi_{300} - \eta_p$ relation (Table 1). The shear stress value (τ_y) called the yield point is a measure of the strength an number of bonds in the card-house structures. As ϕ increases, the gel character becomes more prominent and the shear stress value required to overcome the strength associated with the gel structure to convert it into a fluid structure becomes large.

In Fig. 3, the effect of the volume fraction on $_a$ is given for two different shear rate values. As is observed from the figure, when the shear rate is 600 rpm (1021 sec^{-1}), the change is relatively slow. With increasing clay concentration an increasing fraction of the observed particles consists of face to face associations of the formerly described platelets even the dispersion is made up in deinozed water.

There are various mathematical expressions which give the dependence of viscosity on concentration by volume for systems consisting of a solid and a liquid phase. For a very dilute suspension of non interacting and uncharged spheres in a Newtonian liquid, the viscosity for laminan flow is described by the Einstein equation

$$\eta_s = \eta_l(1 + k\phi),$$

where ϕ is the volume concentration, η_s is the viscosity of suspension, η_l

is the viscosity of suspending medium, k is the apparent hydrodynamic shape factor of the particles, the value of which is about 2.5 for spheres[3-5]. This equation was derived for very specific conditions, that is for extremely dilute suspensions containing non-interacting, non-solvated, hard spheres. The value of k is found to be sensitive to particle shape and is greater than 2.5 for platy, rod-shaped and needle-shaped particles[2]. For much more concentrated suspensions, of up to 50 per cent or so, which are common in industrial casting-slips, the particle-particle collisions become the dominant factor in determining viscosity of the liquid[2]. Equations for

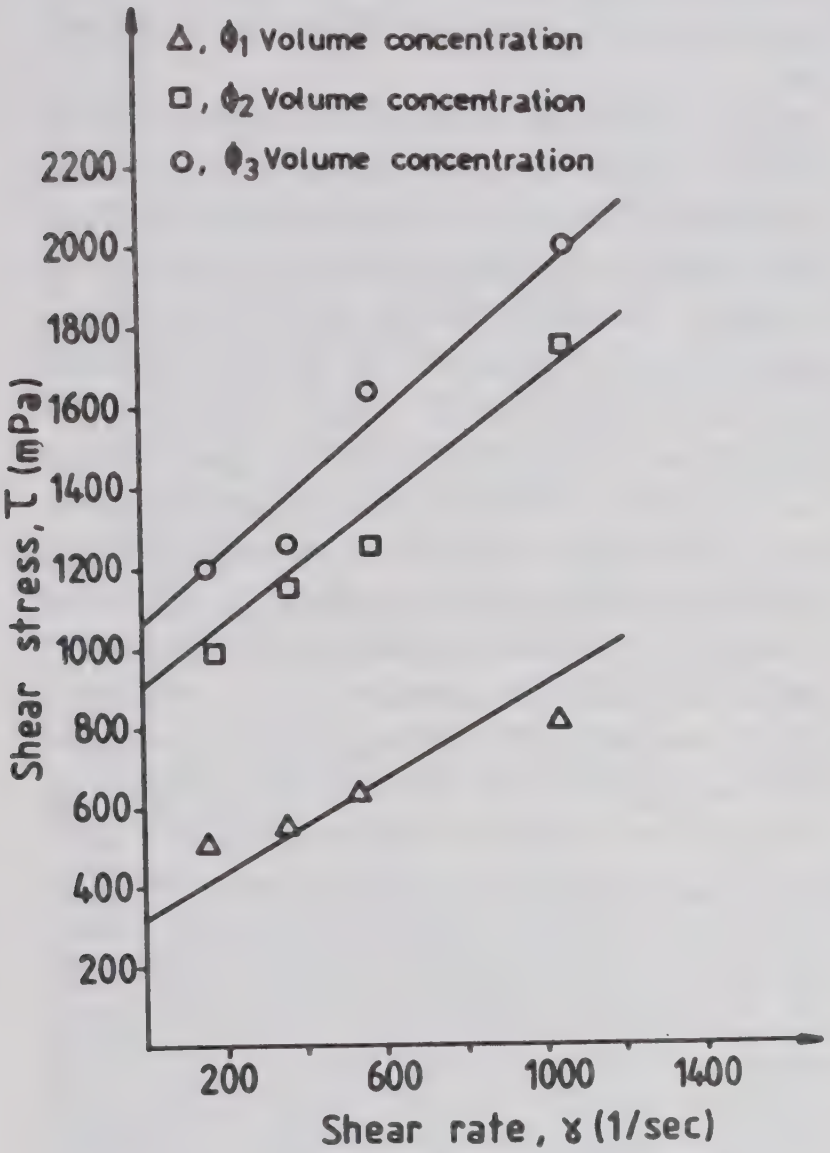

Fig. 2 — Shear stress vs shear rate

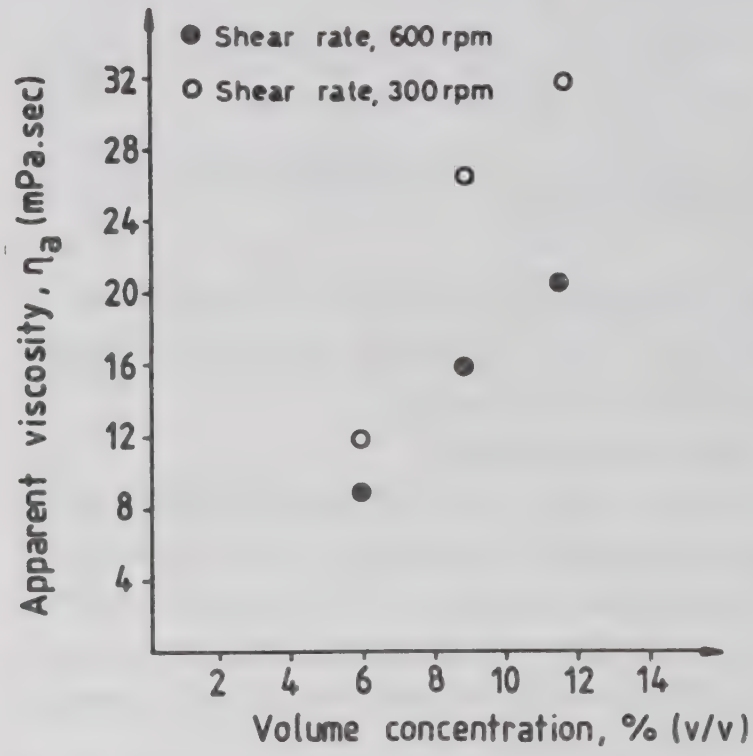

Fig. 3 — Apparent viscosity vs volume concentration

Table 1 — Shear stress values for fluid system

ϕ, volume concentration (v/v)	η_g, apparent viscosity (mPa.s)	η_p, plastic viscosity (mPa.s)	τ_y, yield point (mPa)		pH	Conductivity µs/cm
			Calculated from equation*	Calculated from Fig.2		
6	9	5	2880	3150	7.25	3440
8.8	16	6	9600	9200	7.43	2990
11.4	21	10	10560	10600	8.20	2850

*$\tau_y = \theta_{300} - \eta_p$, θ_{300}, dial reading at 300 rpm, η_p, plastic viscosity

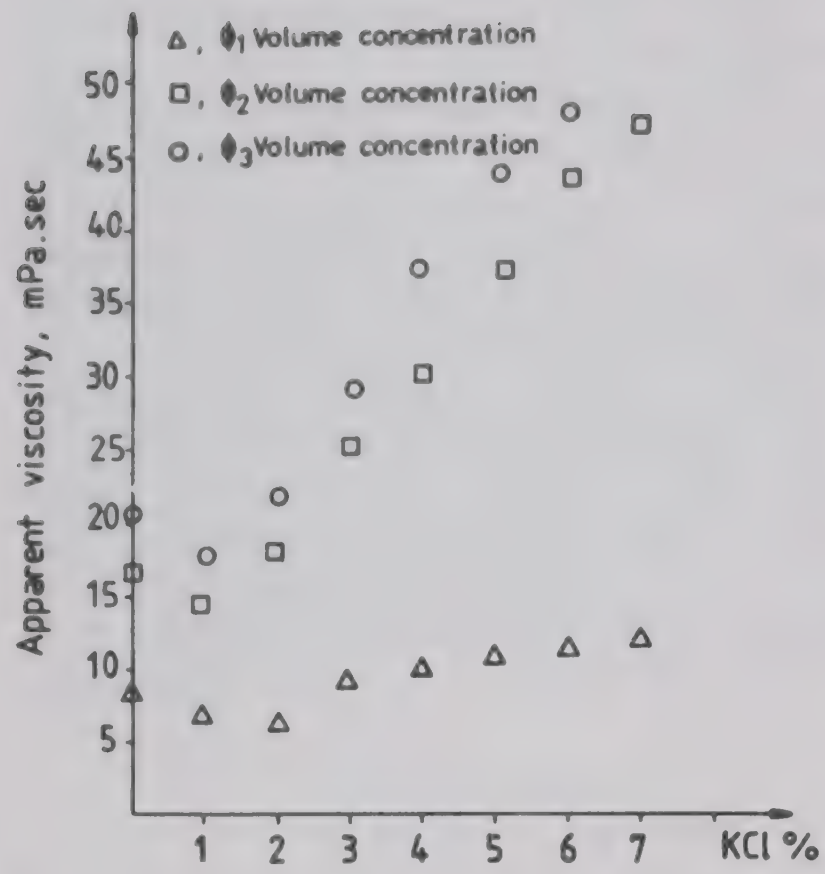

Fig. 4 — The change of the apparent viscosity with KCl electrolyte added to the sample

these concentrated suspensions are often based o a power low, a typical example being that developed by Norton and his associates :

$\eta=\eta_l(1-\phi) + k_1\phi + k_2\phi$,

where, k_1 and k_2 are constants depending on the particle size, and n is another constant, the value of which is approximately 3 for flocculated suspensions. For deflocculated suspensions[2], the value of a was found to be approximately to 12, with very small values for k_1 and k_2.

Norton *et al*. also found empirical relationships between yield value concentration, of the form.

$\tau_y=k_3\phi + k_4\phi^3$

where τ_y yield value and k_3 and k_4 are constants. These equations were clained to be valid for concentrations up to 20 per cent, but beyond this some discrepancy can be expected[2].

For still higher concentrations, on equation of the type used by Mooney[21] may be more applicable :

$\eta_s=\eta_l \exp [a\phi/(1- k\phi)]$,

where a is a constant.

Another relation which is suggested by Daugh-enty-Krieger is given by[1,18]

$$\eta=\eta_l \left(\frac{1}{1-\Phi/\Phi_m}\right)^{k\Phi_m},$$

where ϕ_m is the maximum volume fraction.

The flow behavior of the suspensions is one of the most sensitive indicators for this particle interaction, which can be drastically changed by even small variations in the composition of the medium. These include the concentration and valency of the ions, and organic additives[22]. Shear forces also influence the association of particles, as indicated by the structural viscosity and the thixotropic behaviour of dispersions.

Figure 4 shows the effect on viscosity of KCl salt solutions prepared in 1,2,3,4,5,6 and 7 per cent concentrations by volume and added to three different sludge samples which have different concentrations by volume. It is observed that the KCl salt with a concentration by volume of ϕ_1 has the minimum effect on the fluidity of the sludge. The particular sludge shows an increase in viscosity upon addition of a 2 per cent salt solution, and this increase continues at a decreasing rate until an increase by 39 per cent from the initial value is attained. As part of the K^+ cations from the salt is adsorbed on the negatively charged clay particles, another part is exchanged with the exchangeable cations present among the layers of particles. The adsorbed K^+ ions cause a decrease in the density of charge on the particles, and the K^+ ions which enter the layers enhance the diffusion of water into these regions. The labile K^+ cations push the layers apart and enable more water molecules to enter the region. There is good consistency between the effects of KCl on sludge samples having the concentrations ϕ_1 and ϕ_2 by volume. The presence of larger amounts of solid particles in the medium at these concentrations increases the probability of interactions among them, as well as the possibility of exchange of the K^+ ions with the cations present among the layers. Under such circumstances, the K^+ ions have a large effect on the viscosity of the sludge. With the final addition of the salt, the viscosity of the sludge having concentration ϕ_2 increases by more than 2.5- times that of its original value; whereas, the increase is 2.0- times in the case of the sludge having the concentrations ϕ_3. Such large increases in viscosity indicate the formation of a gel structure.

Figure 5 indicates that the presence of $(NaPO_3)_n$ decreases the viscosities of the sludge samples. The minimum change in viscosity (a decrease of approximately 28 per cent of the original value) is observed

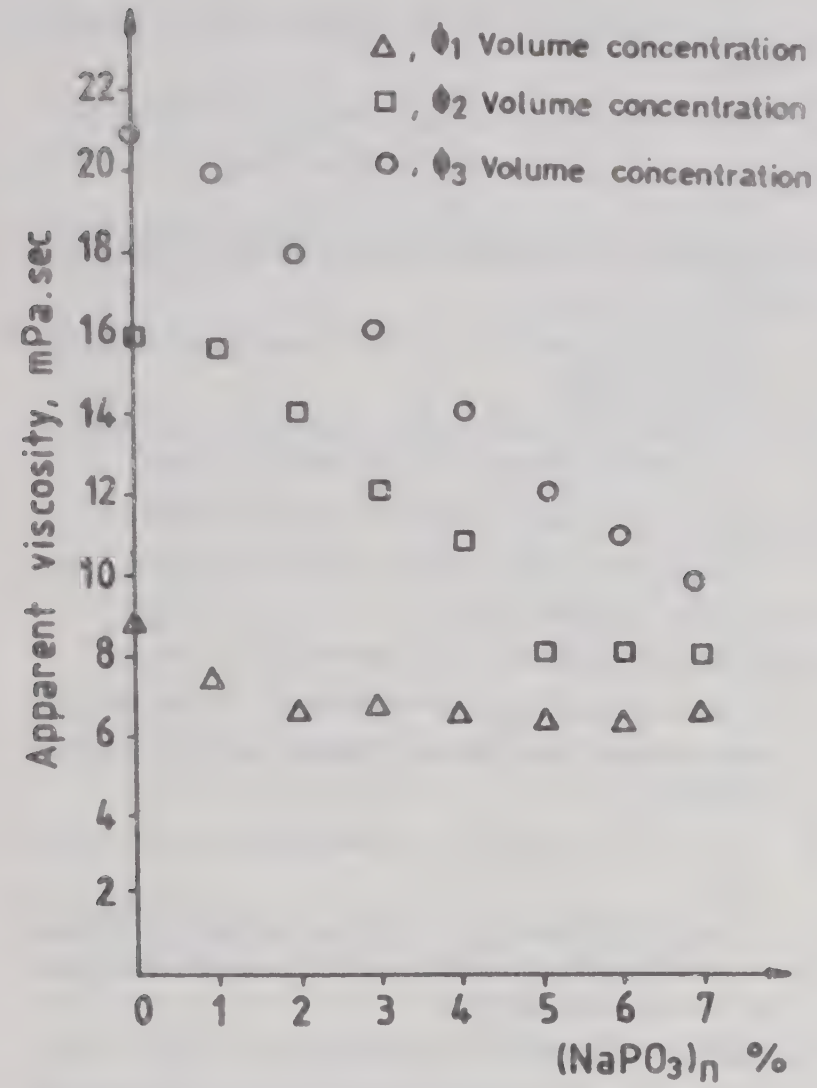

Fig. 5 — The change of the apparent viscosity with $(NaPO_3)_n$ added to the sample

in the case of the concentration ϕ_3 by volume. In the cases of the other two concentrations, the viscosity is reduced to half of the original value when the polymer is added. The adsorption of the polymer on the clay particles decreases the charge on the particles and, thus, diminishes the electrostatic interaction. This prevents the particles from developing a gel structure. Any combinations realized earlier are also destroyed.

The conductivity and the pH values have been determined for the sludges prior to measurements of viscosity. The conductivity has been observed to decrease with increased clay concentration in the sludge. As the number of particles in the liquid medium increases, there are more effective interactions among them which cause a decrease in the amount of charge responsible for conductivity is reduced.

The addition of the polymer to the sludge sample with the concentration of ϕ_1 reduces the conductivity value by one-fourth of its original value. The adsorption of the polymer on the clay particles reduces the charge of the medium which, in turn, lowers the conductivity. On the other hand, in the case of the sample having the concentration ϕ_2, the conductivity increases by 24 per cent of its original value. Since the amount of polymer used is the same, as the number of clay particles in the medium increases, an excess of negative charge develops. This causes the higher conductivities. In the case of the sludge having the concentration of ϕ_3, there is a slight increase (approximately by 4 per cent of the original value) in conductivity. This slight change can be explained by increased interactions among the particles in a medium of high particle concentration which reduces the charge of the medium.

With KCl salt, large increases in conductivity have been observed with the first two sludge samples. In the case of the concentration ϕ_1, the increase is by 109 per cent of the original value; whereas, this is by 211 per cent of its original value for ϕ_2. The adsorption of KCl on clay particles is not as extensive as the adsorption of the polymer. K^+ cations can saturate the particle surfaces, whereas the Cl^- anions can saturate the particle edges and the K^+ ions can also be exchanged with the cations among the layers. Thus, the exchangeable cations can increase the conductivity through their presence in the liquid medium. On the other hand, the K^+ and the Cl^- ions which do not diffuse into the layers can also help to increase the conductivity. The fact that there is not much change in conductivity upon the addition of 2 per cent KCl solution in the case of the concentration ϕ_3 can be explained by the saturation of the increased amount of clay particles by ions of the salt.

Conclusions

(i) The η_a, τ_y values are directly related to concentration by volume of the clay in the sludge and inversely related to the conductivity values.

(ii) The effect of KCl on the viscosities of the three different sludge samples with varying concentrations is similar. The minimum change in viscosity is observed with the sample having the lowest concentration.

(iii) The $(NaPO_3)_n$ polymer, contrary to KCl salt, reduces the rheological values of the sludges.

(iv) Due to the adsorption of the polymer on the clay particles in the sludge the conductivity is reduced; whereas, with KCl salt, as a result of the ion-exchange and the presence of some cations

and anions in the liquid medium the conductivity is increased.

(v) In the use of the bentonite clay sludges in industry, the addition of the $(NaPO_3)_n$ polymer is recommended whenever an decrease in the viscosity of the sludge is necessary; and the addition of KCl salt is recommended if a increase in viscosity is desired.

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Cyanex 925 as a Reagent for the Extraction of Tungsten — Its Recovery from Scheelite and Wolframite

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The extraction behaviour of Mo(VI), W(VI), Al(III), Fe(III), Ca(II), Mn(II), Zn(II), Cd(II) and Pb(II) using Cyanex 925 is reported. The effect of various parameters such as nature of the diluent and concentration of the acid, metal ion and the extractant on the distribution is highlighted. The regeneration and recycling capacity of the extractants has also been assessed. Based on the distribution data, some binary separations are proposed. A procedure developed for the recovery of tungsten from its ores is reported.

Introduction

Tungsten is one of the important hi-tech metals and consequent to its widespread use there is depletion of its natural resources. This necessitates development of methods for its selective extraction from low grade ores. In the past, mainly high molecular weight amines have been employed for this purpose but they suffer from the drawback of emulsion formation. During the last two decades some organophosphorus compounds, particularly di(ethylhexyl) phosphoric acid (HDEHP), have been investigated for the extraction of tungsten[1-3]. A majority of reports on the extraction of tungsten deal mainly with its separation from molybdenum. There are only a few publications related to the separation of tungsten from other metals that are commonly associated with it in ore matrices. During the last decade, some attention was focused on the utilization of a new mixed phosphine oxide extractant, Cyanex 925. Rickelton and Boyle[4] reported the extraction behaviour of Fe(III), Fe(II), Cu(II), Zn(II) and Pb(II) using Cyanex 925. Yadav *et al.*[5] investigated Cyanex 925 for the extractions and separations of some 3d transition metal ions. Alguacil and coworkers[6] explored the possibility of utilizing this extractant for the recovery of Au(I) from cyanide solutions. Suriyachat and Distin[7] compared the utility of Cyanex 925 and Cyanex 923 for the extraction of Zr(IV). Keeping this in view, it was thought interesting to explore the potential of Cyanex 925 for the selective extraction and recovery of W(VI).

In the present paper, extraction of Mo(VI), W(VI), Al(III), Fe(III), Ca(II), Mn(II), Zn(II), Cd(II) and Pb(II) in Cyanex 925 from mineral acid solutions has been reported. The effects of variables like concentration of acid, metal ion and extractant on extraction have also been investigated. Based on the partition data it has been possible to achieve good separations of W(VI) from metal ions such as Mo(VI), Fe(III), Mn(II), Zn(II), Cd(II) and Pb(II). Stimulated by these results, a scheme has been devised for the recovery of pure tungsten from scheelite and wolframite samples at a bench level.

Experimental

Stock solutions of sodium tungstate and ammonium molybdate were standardized gravimetrically. The rest of the metal ion solutions were standardized by the usual complexometric titrimetry. For the distribution studies of Mo(VI), W(VI), Fe(III), Mn(II), Zn(II) and Cd(II) radiotracer technique was used and for Al(III), Ca(II), Pb(II) the phases were analysed using Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES).

Cyanex 925 was obtained from M/s Cytec, USA, and samples of scheelite and wolframite ores were procured from Geological Survey of India, Madras

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Equal volumes of the aqueous phase (metal ion in mineral acid) and organic phase (Cyanex 925 in an appropriate diluent) were shaken at the room temperature (25 ± 2 °C) for 5 minutes to ensure complete equilibration. After separation of the phases, equal volumes of each phase were counted for their activity or assayed by ICP-AES.

About 1g of ore was fused with 5g of sodium hydroxide. The fused mass was leached with water and then filtered. The filtrate and washings were made up to a final volume of 100 mL. The leach solutions from scheelite and wolframite are referred as A and B, respectively in this communication. The residue left in the fused mass after leaching consisting mainly of hydrous oxides of Ca, Mn and Fe, was dissolved in hydrochloric acid and the solution made up to 100 mL. These solutions from residue left after leaching of scheelite and wolframite have been referred as C and D, respectively in this report.

Results and Discussion

Effect of Molarity of Acid

The extraction behaviour of 1.0×10^{-4} *M* of Mo(VI), W(VI), Al(III), Fe(III), Ca(II), Mn(II), Zn(II), Cd(II) and Pb(II) studied from 1.0×10^{-3} *M* to 5.0 *M* HCl using 0.10*M* Cyanex 925 in kerosene (160° - 200° C fraction) is depicted in Fig.1. The extraction of W(VI) with increasing acid molarity first increased to attain a maximum value of 85 % around 0.10 *M* HCl, decreased to a value of 60% at 1.0 *M* HCl and finally became quantitative at 5.0 *M* HCl. Mo(VI) showed quantitative extraction throughout the investigated acidity range. The per cent extraction of Al(III) decreased with increasing concentration of hydrochloric acid. Fe(III) showed quantitative extraction from 1.0×10^{-3} *M* to 1.0×10^{-3} *M* HCl but it dropped to 85% at 5.0 *M* HCl. The extraction of Zn (II) decreased with increasing concentration of hydrochloric acid up to 0.10 *M* HCl, beyond which it increased. The extraction of Ca(II), Mn(II), Cd(II) and Pb(II) was very low (5%) over the entire acid range and is not shown in the figure. The extraction of all these metal ions, except Pb(II), is more or less the same in H_2SO_4 medium.

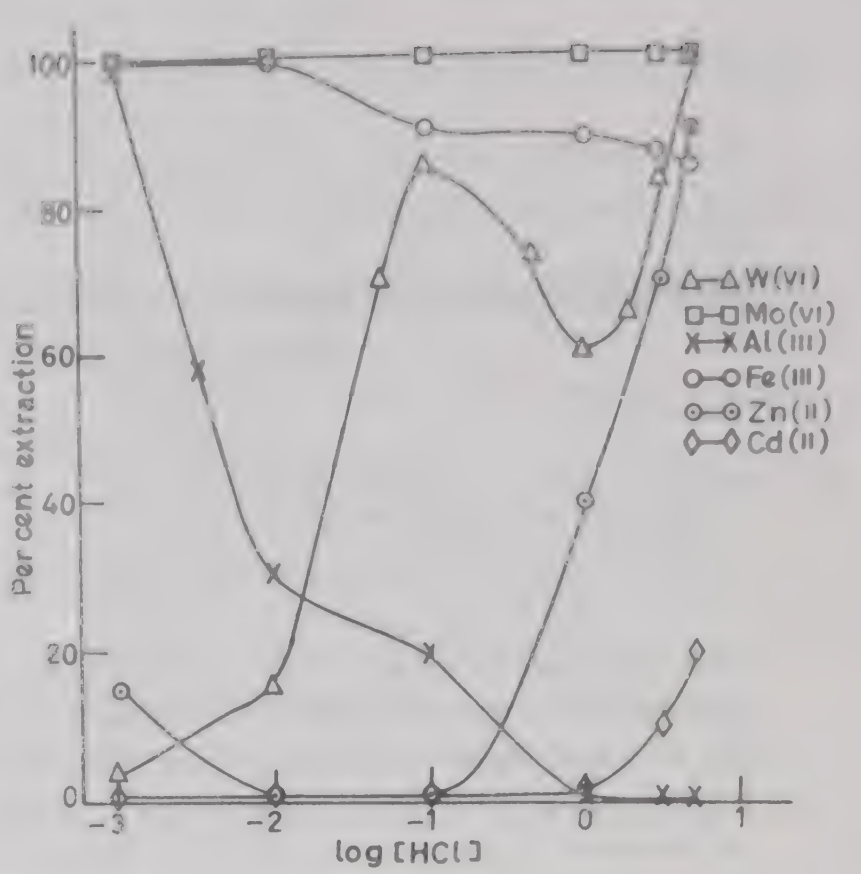


Fig. 1 — Effect of Concentration of hydrochloric acid on extraction of metal ions in 0.10 *M* Cyanex 925

Effect of Diluents

The effect of diluents like hexane, kerosene, toluene, cyclohexanone and nitrobenzene on the extraction of W(VI) from 1.0 *M* and 5.0 *M* HCl in 0.10 *M* Cyanex 925 was investigated. At 5.0 *M* HCl, effect could not be discerned because of the quantitative extraction in all of them. At 1.0 *M* HCl, the highest extraction was observed in nitrobenzene and the lowest in toluene. The dielectric constant appears to have no correlation with the extraction efficiency. The boiling point and the cost considerations make kerosene (160-200°C fraction) as the preferred diluent and all the subsequent studies were made using this diluent.

Effect of Metal Ion Concentration

The results of the effect of concentration of metal ion from 1.0×10^{-6}*M* to 5.0×10^{-4} *M* W(VI) reveal that distribution ratio remains almost the same irrespective of the concentration. Most of the other studies were carried out at 1.0×10^{-4} *M* W(VI) concentration.

Effect of Extractant Concentration

The extraction of W(VI) enhanced with the increase in the concentration of the extractant. The log-log plot (Fig. 2) between the extractant concen-

tration and distribution ratio at two different acid molarities gives a straight line with a slope around 2, suggesting the metal to extractant ratio in the organic phase to be 1:2. The proposed extracting species is $WO_2Cl_2.2$(Cyanex 925). The species is similar to $WO_2Cl_2.2$(TOPO), as postulated by Sato and Saka[8] for the extraction of W(VI) with TOPO.

Separations

The binary separations of W(VI) have been achieved by extracting it either by 5.0/0.10 *M* HCl, leaving the other metal ion in the aqueous phase or by the accompanying metal ion [Fe(III)/Mo(VI)] in the organic layer from 1.0×10^{-3} *M* HCl. For quantitative extraction of W(VI) at 0.10 *M* HCl, the extraction was performed twice. W(VI) was stripped from the organic layer by washing it twice with 1.0 *M* $(NH_4)_2CO_3$ in 1:10 ammonia. The separation conditions and results of separations from binary mixture containing metal ions in different ratios have been summarized in Table 1.

Besides the binary separation, a ternary separation of Mo(VI), W(VI), Zn(II) / Cd(II) was also achieved. Initially, Mo(VI) and W(VI) were separated from Zn(II) / Cd(II) by equilibrating the 0.10 *M* HCl solution containing the mixture twice with the extractant. Mo(VI) and W(VI) were stripped from organic phase by contacting it twice with 1.0 *M* $(NH_4)_2CO_3$

Table 1 — Separation of W(VI) from Mo(VI), Fe(III), Mn(II), Zn(II), Cd(II) and Pb(II)

Metal ions separated	HCl (*M*)	Added metal ion ratios	W(VI)* recovered from organic phase (%)	Mo(VI)*/Fe(III)** recovered from organic phase (%)	W(VI), Fe(III), Mn(II), Zn(II), Cd(II) and Pb(II) remaining in the aqueous phase (%)
W(VI)-Mo(VI)	1.0×10^{-3}	1:1	—	99	96
		1:10	—	98	95
		10:1	—	99	95
W(VI)-Fe(III)	1.0×10^{-3}	1:1	—	98	94
		1:10	—	98	95
		10:1	—	99	95
W(VI)-Fe(II)	5.0	1:1	99	86	14
		1:10	99	85	15
		10:1	99	86	14
W(VI)-Mn(II)	5:0	1:1	99		97
		1:10	99		99
		10:1	99		97
W(VI)-Zn(II)	0.10	1:1	96		99
		1:10	96		97
		10:1	95		97
W(VI)-Cd(II)	0.10	1:1	95		97
		1:10	95		96
		10:1	96		97
W(VI)-Pb(II)	5.0	1:1	99		99
		1:10	99		99
		10:1	99		99

Conditions

[Metal ion (*M*) $= 1.0 \times 10^{-4} - 1.0 \times 10^{-4}$ (1:1)
$1.0 \times 10^{-4} - 1.0 \times 10^{-3}$ (1:10)
$5.0 \times 10^{-4} - 5.0 \times 10^{-5}$ (10:1)

[Cyanex 925] = 0.10*M* in kerosene

* Stripped by using 1.0 *M* $(NH_4)_2CO_3$ in 1:10 ammonia

** Stripped by using 0.10 *M* oxalic acid

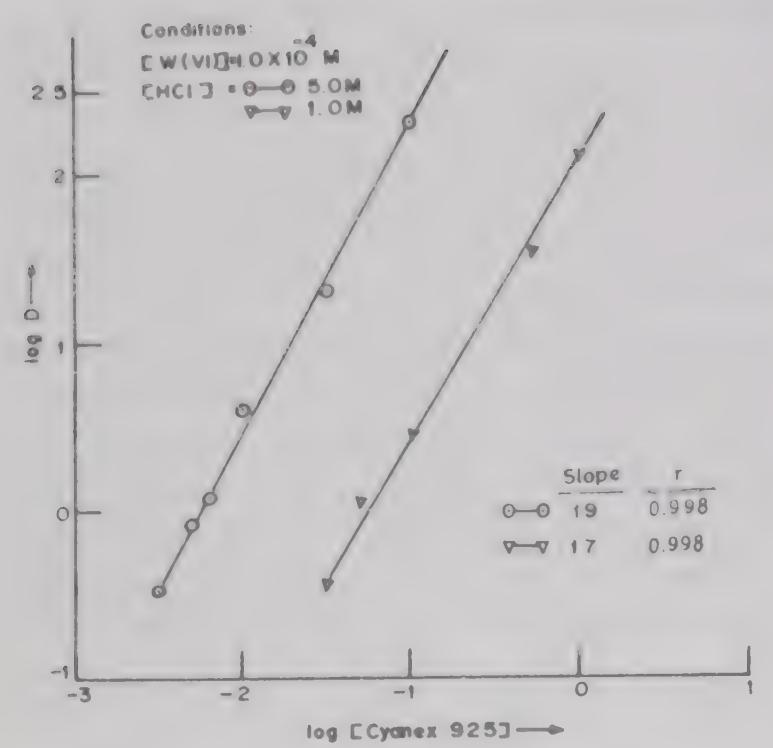


Fig. 2 — Effect of concentration of Cyanex 925 on extraction of W(VI)

in 1.10 ammonia. The separation of Mo(VI) from W(VI) was achieved by Mo(VI) extraction at 1.0×10^{-3} *M* HCl. Finally, Mo(VI) was stripped by equilibrating the organic phase twice with 1.0 *M* $(NH_4)_2CO_3$ in 1:10 ammonia. The recovery of Mo(VI), W(VI) and Zn(II) / Cd(II) was 99%, 96% and 98% / 97%, respectively.

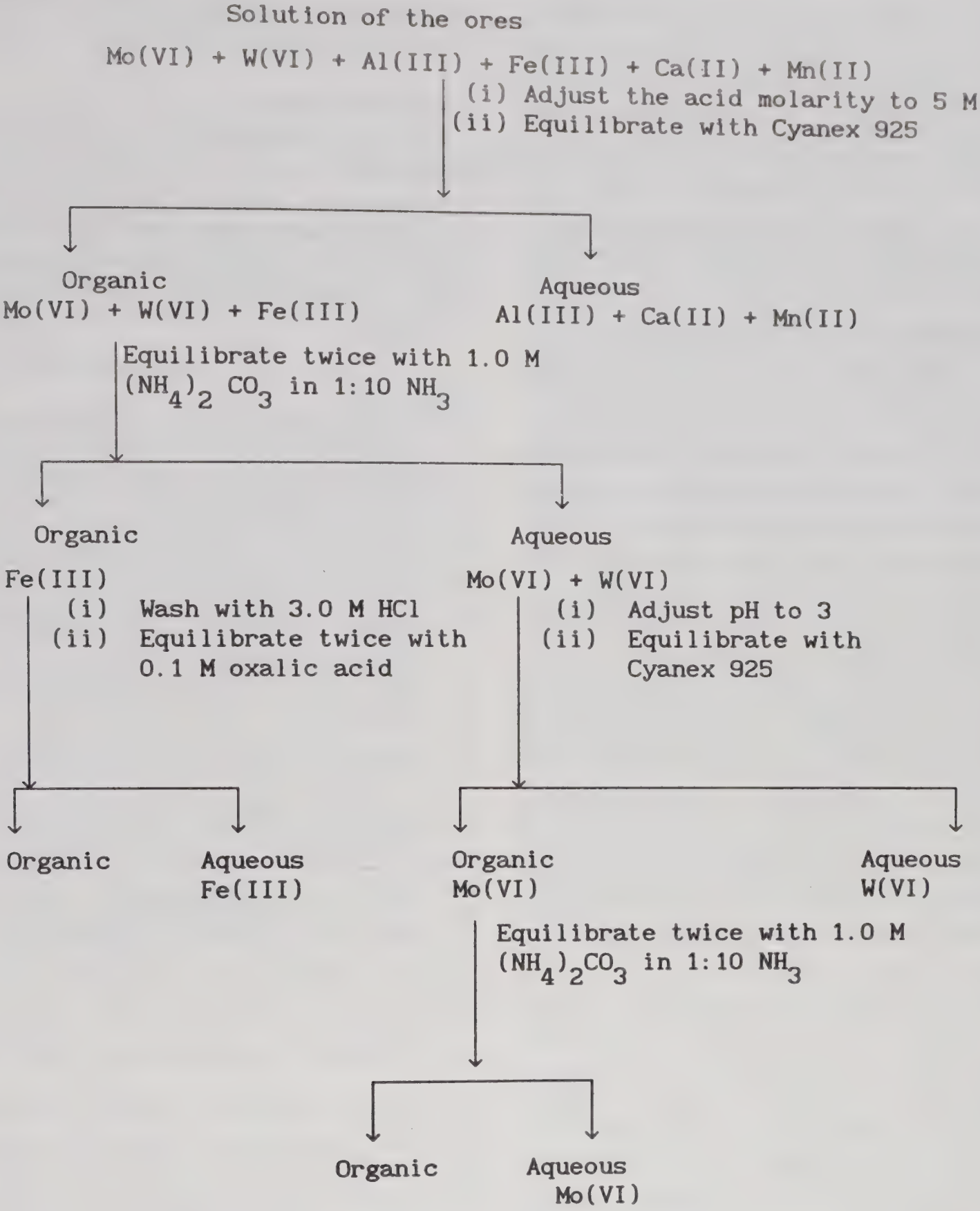
Regeneration and Recycling Capacity

The organic phase, after the removal of W(VI), can be regenerated by equilibrating it with equal volume of 1.0 *M* HCl for 5 minutes and subsequently with water. The regeneration capacity of this extraction system was tested by carrying out successive extraction — stripping cycles for W(VI) from 5.0 *M* in 0.10 *M* kerosene solution of Cyanex 925 up to ten cycles. The results did not show any apparent change in the extractability of the reagent up to ten cycles.

Table 2 — Recovery of tungsten from scheelite and wolframite

S.No.	Sample	Metal ions	Concentration before extraction (ppm)		Concentrations after following procedure shown in Fig. 5 (ppm)		Recovery of tungsten (%)	σ*
			A_1	B_1	A_2	B_2		
1	Leach solution from the main ore	W(VI)	37.5	51.2	36.8	48	98, 93.8	±1%, ±3%
		Mo(VI)	<0.008	0.15	<0.008	<0.008		
		Al(III)	185.0	0.06	<0.03	<0.03		
		Fe(III)	1.25	0.02	0.005	<0.005		
		Ca(II)	0.25	0.02	<0.005	<0.005		
		Mn(II)	<0.002	<0.002	<0.002	<0.002		
			C_1	D_1	C_2	D_2		
2	Leach solution from the residue	W(VI)	0.9	2.8	0.8	2.5	88.9, 89.3	±2%, ±2%
		Al(III)	25.6	0.084	<0.03	<0.03		
		Fe(III)	52.6	65.0	<0.005	<0.005		
		Ca(II)	80.0	18.0	<0.005	<0.005		
		Mn(II)	2.0	80.0	<0.002	<0.002		

* Standard deviation for W(VI) recovery based on five runs
<Based on the detection limit of ICP-AES



* Mo(VI) was recovered from wolframite ore solution

Fig. 3 — Flow sheet for the recovery of tungsten

Recovery of W(VI) from Scheelite and Wolframite

The recovery of tungsten was carried out by appropriately diluting the solution of the ore (experimental section). Solution A was diluted to two fold, B was diluted hundred fold and C and D were both diluted ten fold and these solutions are marked as A_1, B_1, C_1, D_1. Aliquot (10.0 mL) of A_1, B_1, C_1 and D_1 solution was subjected to different extraction steps, indicated in the flow sheet (Fig. 3). The solutions of tungsten obtained from A_1, B_1, C_1 and D_1 solutions after following the proposed procedure are referred to as A_2, B_2, C_2, D_2, respectively. The analytical composition of these solution are given in Table 2.

The present investigation clearly establishes the potential of Cyanex 925 in separating tungsten from a number of closely associated metal ions. Cyanex 925 appears to be a better extractant than Cyanex 921 (TOPO) because of its superior selectivity. Cyanex 923 another solvating reagent, though extracts W(VI) quantitatively over a wide range of acid molarity, but many of the commonly associated metal ions also get co-extracted[9], making the separations difficult. The higher selectivity of Cyanex 925 is attributed to the steric hindrance caused by the presence of branched chain compound, bis(2,4,4-trimethylpentyl)octyl phosphine oxide, as a major component of the extractant[6,7]. Cyanex 925 can be conveniently used to recover tungsten even from a low grade ore or other similar matrices. It can also be reused effectively after regeneration.

Acknowledgements

The authors are grateful to M/s Cytec, USA, for providing the samples of the extractant. Assistance from Geological Survey of India, Madras (India) is thankfully acknowledged. The financial assistance from the Council of Scientific and Industrial Research (CSIR), New Delhi, ndia, is gratefully acknowledged.

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BOOK REVIEWS

Industrial Policy, Technology and International Bargaining: Designing Nuclear Industries in Argentina and Brazil, by Etel Solingen,(Cambridge University Press,Cambridge, UK) 1996 pp 311, Price: 35.00
[ISBN 0 8047 2601 9 (hb)]

From the early 1950s, India had made a commitment to nuclear power. It was constantly reiterated by successive governments that such a commitment would enable India to be in the forefront of modern technology, and enhance its international status and bargaining position. Specifically, nuclear power was expected to contribute substantially to national technological capability and self-reliance. But at the close of the century, it is clear that nuclear power has not been able to provide a reasonable contribution to even the power sector, let alone bringing the additional rewards that were expected of it. Still it continues to receive a major, in fact, dominant fraction of the S&T funds of the country. To what extent is this justified? What has been the contribution of our investment in nuclear power to the enhancement of our international bargaining capability?. It is not easy to get answers to these questions in the Indian context, since the government still does not allow access to information in this area. Hence, it is very interesting to find a book that attempts to tackle these questions in the context of two other large developing countries that had also made early commitments to nuclear power, namely Brazil and Argentina.

Like India, Brazil and Argentina had made commitments in the area of nuclear power, but unlike India, they had explicitly sworn off the weapons option. They also had larger and more confident and dynamic private sectors in relation to the national economy, and had greater linkages with the international technological community. In the case of India, the nuclear explosion of 1974 had ended further international linkages in the nuclear area and we were constrained to be exclusively self- reliant. This did not happen in the case of Brazil and Argentina, and they were able to have and maintain international linkages. But even this did not allow them to properly develop their nuclear industry and to integrate it fully into the national economy. The assumption, common in the developing countries that investment in relatively advanced technological sectors has multiplier effects that allow for shortening of the time needed to develop industrial capability in wide range of areas thus seems to be substantially invalidated.

The book explores this assumption in some depth and examines spinoffs from the nuclear industry. An additional importance of the book is that it approaches the question of nuclear power in the developing countries from an industrial policy viewpoint,whereas most books approach it from a geopolitical perspective. The two countries examined,(Brazil and Argentina), have sufficient differences between them in the relative strengths of the public and private sectors, and the modes in which they interact that the discussion in the book forms a valuable case study on the structures and institutions of industrial policy formulation. The macropolitical consensus and the levels of bureaucratic and institutional autonomy needed for efficient international bargaining are also examined. Thus, from many aspects the book is a valuable addition to the literature on technology and industrial policy.

India shares many attributes with Brazil and Argentina. They are both late comer newly industrializing capitalistic oriented economies with comparable levels of per capita GNP, technoeconomic competence, and levels of state intervention. Though, both are much richer than India in per capita terms, they have many levels of technological capability comparable to us, and the elites share a strong ideological sense of nationalistic self- reliance. Even so, actual achievements in economic and technological self-reliance are much less in all the three countries than in a successful NIC such as South Korea, to take an example. Hence, an analysis of the process of industrial and technology capability development in these three countries is bound to yield some interesting insights. Where Brazil and Argentina differ from us, of course, is in their proneness to authoritarian military rule; on this point they are more akin to Pakistan.

The international political context provided Argentina and Brazil with similar choices and opportunities. As pointed out earlier, their technoeconomic levels and resource endowments were broadly comparable. But the two countries have responded in different ways to the challenges .Moreover, the two cases also provide many puzzling challenges to economic orthodoxy. As compared to Argentina, Brazil had a much larger GDP. Its firms were larger, and it had a very dynamic private sector in industry with considerable technological capability. The private industry also had lot of political clout. At that time, abundant financing was available from international financing institutions to developing countries in Latin America, which would have lessened their dependence on supplier credits (Supplier credits tie purchases to the firms which provide the credit, often at considerable financial cost).Brazil was a particularly favoured recipient of international finance, and hence did not need supplier credits very much. Economic theory would suggest that these factors would contribute to a relatively smaller state level participation and more role for private industry, in Brazil, as compared to Argentina, and that the country as a whole would be able to drive a harder bargain and obtain more favourable terms from the foreign suppliers of technology. But the reverse was the truth. Argentina, the weaker of the two states, obtained much better terms from the technology suppliers, and was able to tie purchases to the participation of its private sector units. Brazil, on the other hand, built up large public sector firms in engineering and construction which failed to obtain as good terms as Argentina from the technology suppliers. The public sector units competed with the private sector in a limited market, lowering overall viability for all the national firms. Thus, structural power arguments fail to predict overall domestic participation , the relative mixes of public and private entrepreneurship and terms under which technology is obtained from abroad. The author therefore looks for alternative explanations in two key areas :(i) macropolitical consensus and (ii) bureaucratic autonomy.

Macropolitical goals are those at the apex of a state's hierarchy of goals and means, expressed in various policy priorities. Thus, for instance, Japan, S Korea, and Taiwan at varying times had a macropolitical goal of export led growth. India opted for self-reliance, national security and non-alignment. When there is broad agreement between the strong political actors on the macropolitical goals, a consensus on it is built up. The consensus is expressed by policy goals, formulated and implemented by a bureaucracy. The autonomy of the bureaucracy refers to the freedom and commitment with which it can pursue the goals without interference from the political establishment. Lateral autonomy refers to the capacity to define and carry out policy independently of the interference by the other units, and vertical autonomy refers to the independence it has vis-a-vis the top political executive. If the national executive system more or less rubber stamps a bureaucracy's agenda, then that agency has high vertical autonomy.(This is still the case with the Indian Atomic Establishment). Lateral autonomy shields an agency from bureaucratic cross cutting pressures from other agencies. Its logical opposite is lateral segmentation, where a number of agencies have overlapping jurisdictions over the definition or implementation of a policy. The logical opposite of vertical autonomy is vertical centralization where decision making in an area is effectively concentrated at the top executive level.

Armed with this model, the author proceeds to analyse the process of decision making in the nuclear area in Brazil and Argentina. Brazil is found to be a case of strong macropolitical consensus, with segmented and centralized decision making. This constrained the range of options available for the implementation of nuclear policy. State enterprises and foreign technology became the means by which the nuclear program was to be achieved, severely reducing the room for national private enterprise. Argentina had a low macropolitical consensus and a tripartite division of the state among the three wings of the armed forces. This strengthened the lateral as well as the vertical autonomy of the nuclear establishment, and allowed them to lay more emphasis on the participation of the national private sector, and to drive a harder bargain with the technology suppliers. Various aspects of the nuclear policy and performance of the two countries are explained, based on this premise.

A relatively surprising finding of the model is that a high degree of macropolitical consensus is by no means an unmixed blessing. While high consensus allows for effective implementation of policy by

inhibiting conflicting demands, it also reduces the room for manoeuvre among the negotiators and prevents them from using domestic pressures as a bargaining chip to extract concessions from suppliers. It also reduces flexibility in adapting policies and changing goals to cope with changing international contexts. Some of the difficulties can be offset if the implementing agency has high levels of real autonomy and the country has a tradition of goal-oriented decentralized decision making. But where this is not the case ,high consensus actually acts against achieving the stated goals.

The author examines the question of spinoffs from the nuclear program, often emphasized by proponents of nuclear power in the developing countries to justify the heavy investments. She finds relatively little evidence for positive spinoffs that benefited the entire economy. On the contrary, by siphoning off resources from other areas, nuclear power appears to have had a relatively negative impact. In engineering sector, the large investments in reactor vessel fabrication,etc.in Brazil could not be transferred to other areas. Sectoral concentrations of over-skilled labour in a few areas did not translate to upgrading of skills in the industrial sector as a whole. There were no significant export opportunities. The advantages cited, e.g.in quality control, could have been achieved at much lesser costs by dedicated programs, since the levels required in the nuclear program were too high for the civilian economy. The opportunity costs of foregone investments in other areas with higher social benefits, such as conventional energy sector, were considerable. Altogether, the nuclear power program at best created some artificial islands of high technology.

The findings of the book are of considerable significance as far as India is concerned. A book with comparable analysis of India's nuclear program, from an industrial policy angle does not exist. The methodology adopted by the author offers considerable insights. However, a few problems may also be pointed out. Some of the insights claimed for the methodology actually emerge from a post-facto analysis, and do not follow from the premises cited. The impact of the efficiencies of implementation which can mitigate for a lot of the incoherence of policy is not adequately explored. There is no evidence that the relative advantages claimed by Argentina have resulted in an overall better nuclear power program in that country. The claim for a weak macro-political consensus translating into better bargaining position does not carry much conviction, since a large number of counter examples can be cited. But the emphasis on bureaucratic autonomy is quite valid, and we can learn from the book on the optimal mix of autonomy and accountability. The lack of evidence for spinoffs also is significant, because it serves to correct the large claims made by our nuclear establishment.

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Beyond Free Trade — Firms, Governments and Global Competition, edited by David B Yoffie (Harvard Business School Press, Boston MA 02163) pp 496, Price: $ 45.00
[ISBN 0 87584 344 1]

It is an anachronism of today's world that while the ideology of free trade and liberalization has achieved a major success with the signing of the World Trade Agreement, it has received major blows from the developments in the academic world. The theoretical underpinnings of the ideology of free trade, the theory of comparative advantage was shaken with the discovery of the Leontief paradox which showed that contrary to the expectations of this theory, the exports of the United States of America were more labour intensive than its imports. For the last few decades, efforts have been going on to shore up the theory in spite of this empirical evidence. But the onslaught against this theory received further momentum in the last decade with the appearance of alternate theories such as the strategic trade theory. Particularly popular in this genre has been the theoretical framework put forward by Michael Porter on the 'Competitive Advantage of Nations'*. The book under review is a book in the tradition set forth by Porter.

This volume has been edited to put together the work which resulted from a three year project at the Harvard Business School. The book positions its argument as a modification of the thesis of Porter about the competitive advantage of nations and seems to be arguing that the exercise of market power by firms and political intervention by governments have to be taken into account in case the pattern of trade flows have to be explained.On this basis a

*Porter Michael E, *The Competitive Advantage of Nations*, (Macmillan, UK) 1990.

topology is put forward by considering the matrix generated by the interplay of low or high industry concentration and low or high government intervention. It is argued that the trade structure only in the industries that are low in industry concentration and government intervention can be understood in terms of country-specific factors. Industries with high levels of concentration and government intervention such as semi-conductors, computers, telecommunication and automobiles have been covered in this volume and they bring out clearly how the market power of the multinational enterprises as well as the political intervention are crucial for understanding the current pattern of trade . As against this, industries such as bearings, construction equipment and minerals have been shown to be industries where the visible hands of the global firms is what determines the pattern of trade. The case of the international insurance industry is studied as a case with low international industry concentration and where the determining role is played by the visible hand of the government.

Of course the authors do make it clear that in the case of all the industries the country specific factors such as the characteristics of factor supply, the demand conditions, the structure of industry and the existence of supporting and related industries, the famous 'diamond' of Porter are very important. But what is being put forward is that apart from this, the impact of the market power of the multinational enterprises and the intervention of governments also have to be considered in case the structure of international trade is to be understood. The market power of the companies is what allows them to cross- subsidize their products from sometimes a high cost location in order to fulfill strategic objectives and in such cases the internal characteristic of that nation alone cannot give a clue about the location of a particular facility for export in that country. The interplay of firm specific and country specific factors need to be considered to understand the location of individual production sites. Thus, e.g. as one of the authors argues, Thailand would not be a good location for a Thai company without access to the economies of scope to locate the facilities to produce bearings for the aerospace industry, but for a Japanese conglomerate it would be a good location.

Another important point which has been brought forward by the studies is the importance of history or what they call corporate inertia in explaining the current pattern of trade. The studies in this book are replete with the examples of how trade is influenced by the path dependencies. Unfortunately, this aspect of the real world is something most of the 'rigorous' and quantitative studies fail to recognize.

Case studies in this book form a valuable contribution to penetrating the actual mechanisms which underlie the pattern of trade. One only wishes that the implications of these mechanisms would also inform the industrial policy decisions being taken in the developing countries such as India.

Yet at the same time, it is our contention that this contribution has to be seen as a complement to the thesis of Michael Porter and not as a modification, because the questions being asked in the two cases are slightly different. As has been very powerfully brought forward in this study the current pattern of international trade can be explained only by considering the factors put forward by Yoffie and others. But the concern of Michael Porter was different in the sense that he was asking the question of what determines the nationality of the firms who succeed internationally? In fact, Porter starts out with the firm and ends up with the nation. The nationality of the firm is important in the case of Porter because there the attempt is to unravel the source of the wealth of nations in today's context and not so much the pattern of trade. Therefore the decision of a multinational enterprise to locate a particular facility in a nation is not that relevant as the case why a firm from a particular nation becomes successful. It is by being the home country of a multinational enterprise that the maximum extent of sustainable advantage can accrue to a nation from the activity of a multinational enterprise. The existence of the 'diamond' in a nation which gets supported by government policy comes out to be the rationale in these studies also for the existence of national firms that are successful in international trade.

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The Physical Sciences—An Integrated Approach, by Robert M Hazen and James Trefil (John Wiley & Sons, West Sussex, UK) 1996, pp xxii + 742, Price: £ 19.99
[ISBN 0 471 00249 6]

Science education is undergoing sea change with the coming of the electronic age. Yet, the printed book still holds its sway as the main educational material used by the majority of students, even in the advanced countries. There is also a visible shift in the objective science education aims to achieve. For the majority who study science in college it is no longer to make them professional scientists. Rather it is for the simple reason that learning about the central ideas and methods of science empowers everyone to make informed decisions about issues that affect work, family and other aspects of daily life. In fact there is much more to science than this. The scientifically literate student is better equipped to share in the excitement of scientific discoveries that, week by week, transform our understanding of the universe and our place in it. But unless presented in a style that would not only make it comprehensible but also attractive, science could be a dull subject. And that is where *The Physical Sciences* scores over other conventional texts.

Departing from the traditional approach of treating science as distinct separate disciplines, the authors have organized the text around a series of 22 scientific concepts beginning with the basic concept of science as a way of answering questions about the physical universe, followed by the idea of mathematics as the universal language of science. Then follow some of the basic principles shared by all sciences, such as Newton's laws governing forces and motion, the laws of thermodynamics that govern energy and entropy, the equivalence of electricity and magnetism and the atomic structure of matter. "These concepts", say the authors in the Preface, "apply to everyday life and explain, for example, the compelling reasons for wearing seat belts, the circulation of blood, the dynamics of a pot of soup, and the regulation of public airwaves." Other chapters are devoted to the atomic nucleus, subatomic particles, the theory of relativity, plate tectonics, astronomy and cosmology.

One can find most of these ideas in any elementary science textbook but mostly in abstract form. Rarely do they relate to the real-life experience of the students. But here the authors have made conscious efforts to bring in as many everyday examples as possible to illustrate or explain concepts. Another unique feature is the incorporation of brief sections in every chapter aimed at helping the student to correlate scientific principles with technology, develop intuitive skills, understand the environmental issues involved, trace the history of scientific discoveries and examine the interplay of science and society.

The book features five levels of end-of-chapter questions to test the student's grasp of the subject. Review questions' are aimed at testing the most important factual information covered in the text while 'Fill-in-the Blanks' emphasize important words and phrases that every student should know. 'Discussion Questions' test student comprehension and the ability to apply scientific concepts. 'Problems' are quantitative questions while 'Investigations' require additional inputs from outside the classroom. There are plenty of solved problems to enable the student to get a better understanding of the principles and concepts. And there are superb photographs and line drawings. The appendices include tables of SI units, conversion tables, geological and astronomical data and, interestingly, 12 colour maps of the sky at night as seen from the northern hemisphere which will be useful as ready references.

If only for its original and innovative style of presentation, *The Physical Sciences* will make an excellent introductory text not only for students but for any reader interested in knowing what science is all about.

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SCI-TECH UPDATE

Consortium to revolutionize high-performance computing

The National Science Foundation selected a consortium called National Partnership for Advanced Computational Infrastructure (NPACI) in which two Stanford projects have been chosen to participate in a new effort to upgrade USA's high-performance computing environment. One of the Stanford Projects is headed by Russ B Altman whose project centers on analyzing the architecture of large biological molecules. Garcia-Molina heads the Stanford Digital Library project, which has the goal of uniting the varied information sources available on the Internet into a single virtual library system.

The purpose of the project is to develop the infrastructure for the US scientists' need to tackle currently intractable scientific and engineering problems, such as climate and weather prediction, complex drug design and the creation of new materials with desired characteristics.

NPACI includes 37 research institutions and builds on the San Diego super computer Center established at UCSD in 1985. The other California participants include California Institute of Technology; Lawrence Berkeley and Lawrence Livermore National Laboratories; and the University of California's Berkeley, San Francisco, Davis and Santa Barbara campuses.

Altman expressed that the focus of the NPACI grant on molecular science and digital libraries fits perfectly with parts of his research in the analysis of protein structure and function, as well as with new ways of representing the published biomedical literature.

With the new support, Altman will adapt algorithms for analyzing molecular structure so that they will work with massively parallel computers. This will make these tools available to biologists around the world.

The Stanford Digital Library project was started in 1994 with funding from the National Science Foundation, the Defence Advanced Research Projects Agency and the National Aeronautics and Space Administration. Its goal is to develop the technology required to integrate the broad range of information repositories available over the Internet into a universal, virtual library system.

A large number of information resources, services and libraries will be developed as part of the new effort. The efforts of the consortium aim at creating a national mega-computing environment, which will consist of geographically separated high-performance computers, data servers, and archival storage and visualization systems linked by high-speed networks so that their aggregate power may be applied to the most complex research problems that cannot be studied any other way [*Stanford News*, Stanford University News Service, 4 February 1997] ❑

DSRM

Computer recognition of facial expressions across low bandwidth

Researchers Yaser Yacoob and Larry S Davis at the Computer Vision Laboratory, Centre for Automation Research University of Maryland, College Park, Md, have reported some attempts to analyse and recognize facial expressions from image sequences. This, it is believed, may lead one day to see that your computer will recognize the faces you pull up when an unpleasant or unexpected action was taken while working with it.

The work stresses the importance of visual communication in human communication and interaction. If successful, these attempts open up possibilities for better video transmission of facial expressions across low band width systems. The researchers say that low bandwidth transmission of facial data can be made more efficient by using mid and high-level visual representation of facial actions. Previous workers have analysed the six principal

expressions of happiness, sadness, surprise, fear, anger, and disgust but have tended to concentrate on static "mug shots".

Yacoob's team developed algorithms that use optical flow computation to identify the direction of rigid and non-rigid motions caused by human facial expressions, and have so far demonstrated recognition of the six expressions on a large set of images.

The analysis is carried out by tracking rectangles that enclose the facial features. Every rectangle encloses one feature of interest. Trials have been conducted on 32 subjects in which each was asked to display the expressions of emotion in front of a video camera. Initial experiments showed that cues to detect the beginning of "fear" include the inward raising of the eyebrow and opening of the mouth. Although some confusion still exists to distinguish between various expressions, the researchers claim that they were able to report a "good" classification of facial expressions in more than 30 subjects in a very large database [*Electron Wrld*, **102** (1728) (1996) 914].❑

DSRM

Computerized stethoscope

The Ubiquitous stethoscope noticed on every doctor's neck is touching a level of sophistication by the Sussex University's Heart Sound Group, UK by their designing a computer based stethoscope.

The new, relatively low cost diagnostic tool analyses the digitized sound of heart beats and conveys the data to a standard personal computer. The digital data are recorded on computer disk for further analysis and extracting relevant features. Further, each recording is stored on the disk and compared with earlier data to find out whether any changes in the condition of the heart occurred.

The main advantage of this gadget is that it does away with the subjective judgment of the heart condition which helps in the building up of a long-term record of the state of the heart and makes diagnosing problems easier.

Using the data obtained and stored on hard disk, the Sussex University team is concentrating on the possibility of identifying the kind of trace that is typical of sufferers of aortic stenosis.

Trials are being conducted on cardiac patients at the Royal Sussex County Hospital, southern England. Efforts are also on to develop software that will recognize the problem in the trace of a new patient and will asses how far the condition has developed.

Although echocardiograms producing an on-screen 3D computer image are available, the new device is relatively cheap costing around 2000 pounds as compared to the price of echocardiograms which cost about 10 000 pounds.

More information can be had from Dr John Tory, School of Engineering, University of Sussex, Falmer, Brighton [*Spectrum, Brit Sci News*, No. 257, March-April 1997, p. 18]. ❑

DSRM

First step to the 'molecular computer'

Prof. Fraser Stoddard at the Birmingham University in collaboration with Prof. David Williams of the Imperial College, London have created the first synthetic molecule that may lead to new ways of data storage and eventually to the development of a 'molecular computer'. The molecule is known as *Olympiadane* because its shape resembles the Olympic games symbol.

The researchers use a crystal diffractometer with X-ray source to see and analyse the synthetic molecule they have created. This is a success because of three factors: (i) a new way of assembling molecular components; (ii) persuading the resulting molecules of Olympiadane to aggregate to form crystals capable of being studied by single crystal X-ray diffraction technique; and (iii) unravelling the X-ray data to reveal the highly complex 3-*d* molecular structure.

The successful linkage of complex synthetic molecules means that molecular chains of any length could be constructed with many applications. This may open up the possibility of storing data within molecules rather than on silicon chips. Olympiadane might be viewed symbolically as prototype for the construction of molecular switches and other devices.

For further information contact: Department of Chemistry, University of Birmingham, Edgbaston, Birmingham B15 .2TT, UK. ❑

HKK

High density removable cartridge for data storage

After spending three-years on an Espirit project of EC, the French data storage specialist Nomai has brought out a highly successful removable hard disk drive. The new standard is being supported around the word.

Normai's new Power Disc Cartridge has many benefits. Firstly, end-users get 540 MB storage capacity, almost that of a hard disc, in a cartridge of the same size as a 3.5" floppy. Thus data can be transported in a pocket-sized cartridge equivalent to 400 floppies, or 60 min of MPEG film or 800 colour pictures. Secondly, the new drive is fully compatible with other manufacturer's cartridges particularly with the Syquest 270 MB cartridge. The disc is also claimed to be compatible forward and backward which allows new data to be recorded in the order or sequence required. The meanlife before technical failure (MBTF) is about 250,000 hr.

The company has created a new world standard in removable hard disc technology named PDC (Power Disc Cartridge) in cooperation with US SyQuest which is also supported by other leading makers of similar product. [*Innov Technol Transfer*, European Commission, Brussels, 2(1997)20]. ❑

DSRM

Smart electro-chromic windows

Electro-chromic (ec) windows-windows having glass that can be darkened or lightened automatically or at the touch of a button offer one simple solution for reducing the power consumption in summer. The practical realization of such smart windows is fraught with problems of arriving at a technology that can design system with acceptable life and cost.

A breakthrough in this direction is made at the National Renewable Energy Laboratories (NREL) in Colorado which has developed an all-solid state electro-chromic device that can be switched over a range of optical transmissions by voltages of less than 1 V. It should be possible to power the devices by an integrated semi-transparent photo-voltaic (pv) cell, so removing the associated wiring costs that substantially push up investment in ec windows.

In the NREL system, indium-tin-oxide (ito)-coated glass forms the electrically conductive transparent substrate for the device, onto which thin films of WO_3, MgF_2 and V_2O_5 are deposited, topped by a semi-transparent gold electrode.

Colouration occurs by a complex reaction between the clear WO_3 and a light-absorbing compound of lithium and WO_3. The reaction involves injection and extraction of electrons and metal ions. The low voltage switching is possible due to inclusion of the MgF_2 layer which acts as the lithium ion conducting layer.

When electrical connection is made, the device transmission drops to about 40% of its bleached-state level in around 60 s. To return to the original transparent state, the device simply needs to be short circuited to cause spontaneous bleaching within minutes.

The NREL researchers say that in practical devices the gold electrode would be replaced with a much thicker transparent electrode that would also control the water content of the device. Current cost of ec windows is around \$ 1000/m^2.

Further information can be had from Clemens Bechinger, Universitaet Konstanz, D-78434 Konstanz, Germany. e-mail clemens. bechinger@uni-konstanz.de [*Electron Wrld*, **102** (1728) (1996) 916]. ❑

DSRM

Novel way of viscosity measurement

Fisher-Rosemount engineers have developed a novel dynamic viscosity measurement method without the need for sampling. The method using a high reliability non-intrusive 'Micromotion'

Coriolis instrumentation is particularly suited to quality control applications in confectionery, chemicals and oil production.

In this method, the mass flow meter is installed in-line with a Rosemount 3051 differential pressure transmitter across its pipe connections. Under flowing conditions, a viscosity measurement is mathematically derived from the dynamic mass flow, density and temperature measurements made by the Micro Motion meter, and a differential pressure measurement across the meter made by the 3051 pressure transmitter. The calculation is performed in the Micro Motion RFT 9739 transmitter which pro-

vides a real-time viscosity output with an accuracy of 1.2% of reading in absolute or kinetic units. The viscosity reading can also be displayed.

In the Micro Motion meter, the coriolis effect induces changes in the oscillation of a pair of vibrating U-shaped tubes as fluid flows through them. Monitoring these changes allows mass flow to be calculated. Density is derived from the frequency of the oscillations.

Micro Motion company is a pioneer in the use of coriolis instruments holding a large percentage of the world market with a wide range [*J Brit Inst Non-destr Testg*,**39**(1)(1997)61]. ❑

DSRM

Recipes for sensors

Nathan Lewis *et al*. at Caltech, have made a nose chip with 10,000 sensors to look up a large number of sensors that each responds slightly differently to odour. They have developed a simple way to do it, in fact, Lewis has offered it as a science fair project for teenagers.

Commercially available plastics are used to make these sensors. Viewed under a microscope, these plastics are a tangled mass of fibres, which swell when odour molecules are absorbed in-between the strands. This has been experimented with polystyrene, which is used to make disposable coffee cups, and polyvinyl alcohol, which is used in plastic food wrapping.

Particles of carbon black (an electrical conductor found in pencil lead and car tyres) are then scattered among the strands of the polymers. Because the polymers are non-conducting, electric current can flow through them only where there is pathway formed by carbon black particles. When colour molecules make the polymer swell, the particles are spread gradually farther apart, breaking up the pathways and thus reducing the conductivity of the material. Virtually any plastic can be used.

Different plastic sensors swell to different degrees depending on their chemical affinities. Polyvinyl alcohol, e.g., is hydrophilic. A sensor which is made from this material will readily soak up the watery odour of wine, thereby causing conductivity to fall markedly. In contrast, polystyrene is hydrophobic. Exposed to the same wine, it would not swell as much as the polyvinyl alcohol, and its conductivity would drop less.

In addition to using different plastics, the cooks at Caltech can create an even greater variety of sensors by varying the amount of carbon black they fold in. Two sensors of the same plastic, one with 10% by weight of carbon black, the other with 20%, would swell by the same amount when exposed to a particular odour, but the conductivity of the sensor with less carbon black would decrease by more, because more of the conducting pathways would be broken. By mixing polymers with varying amounts of carbon black, Lewis believes he can make the large number of sensors he would need for his nose chip.

Is there a limit to the number of different sensors one can make this way? "How many different types of plastics can one buy"? asks Lewis [*New Sci*,**153**(No.2070)(1997)p.28]. ❑

HKK

High-tech pollution sensors for cars

Researchers at the University of Warwick, England, are coordinating Europe-wide research project to design high- technology pollution monitoring equipment for cars.

They are developing pollution sensors that will provide detailed analysis required for constant monitoring of both car emissions and air quality inside vehicles. The work follows increasingly tough environmental legislation being passed into law in both Europe and North America.

The sophisticated microchip-based sensors use conducting polymers and semi-conducting oxides to analyse accurately a range of gases.

They are capable of using normal car-power supply to perform tasks earlier not possible without access to power demands in excess of that normally available from the battery. Motor manufacturers predict that the project could lead to the installation of such sensors in millions of cars in the coming 10y.

For further information, contact:

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HKK

Adjustable low-cost spectacles

Joshna Silver of the University of Oxford, UK has invented low- cost spectacles in which the lenses can be adjusted by the users for themselves, quickly and simply.

On first inspection, the "glasses" look just like conventional ones. But they are very different: each lens comprises two membranes of transparent polyester sealed onto a carrying ring within a frame.

The space between the membranes is filled with liquid by means of a tiny duct to which the wearer attaches a syringe. A varying amount of liquid is injected and when the correct focus reaches, the syringe is removed and the duct sealed. A power range of about +4 to -4 dioptres can be provided and is reckoned to be suitable for about 80 per cent of people.

The lens works in a similar way to the human eye. Both lenses are variable-focus, but with the human eye the system is auto- focusing. Dr Silver's glasses are an extension of the eye and brain's adaptive system, except that the correction is made manually.

Exploratory field trials, supported by the World Health Organisation and Britain's Overseas Development Agency, also attended by an optometrist, have been carried out in Ghana. A group of people needing near-vision correction tested the glasses with interesting results. One person, a tailor, was able to improve the quality of his work immediately. And others, who when given correction, had their ability to read restored [*Brit Commerc News*, May-June 1997]. ❑

HKK

Ice near south pole of moon

The interpretation of data and pictures taken during the Clementine spacecraft mission under the joint programme of U.S. Department of Defense and National Aeronautics and Space Administration has shown that deposits of ice could exist in permanently dark regions near the south pole of the moon.

Initial estimates have suggested that the ice deposit area is the size of a small lake (60-120 thousand m^3). The ice is suggested to be in a lunar crater which has a depth of one-and-a-half times the height of Mount Everest with a rim circumference twice the size of the island of Puerto Rico.

Originally sponsored by the Ballistic Missile Defense Organization (BMDO), the Clementine mission was designed to test new technology that would track and intercept hostile missiles, using celestial bodies such as the moon. Clementine was launched on January 25, 1994 at a quarter of the cost of other comparable satellites. Several advanced lightweight cameras on board Clementine recorded approximately 1.5 million images of over 99.9 per cent of the moon's surface, including laser radar measurements which produced a topographical map of the lunar surface.

The discovery of ice on the moon has enormous implications for a permanent human return to the moon. Water ice is made up of hydrogen and oxygen, two elements vital to human life and space operations. Lunar ice could be mined and dissociated into hydrogen and oxygen by electric power provided by solar panels or a nuclear generator. Hydrogen and oxygen which are prime components of rocket fuel can be used to refuel rockets at a lunar filling station and making transport to and from the moon more economical by at least a factor of 10. Additionally, the water from lunar polar ice and oxygen generated from the ice could support a permanent facility or outpost on the moon. The discovery of ice, which is so vital to human life and operations in space, will make human expansion into the solar system easier.

The Clementine mission was sponsored and managed by the BMDO. The satellite was designed and integrated by the Naval Research Laboratory and the sensor instruments were integrated by the Lawrence Livermore Laboratory. The science team was sponsored by NASA who also provided the Deep Space Network of antennas to receive Clementine's image transmissions to the earth. Clementine was launched aboard a Titan II missile from Vandenberg Air Force Base, California. [*Sci Update*, United States Information Service, New Delhi, Jan-Feb 1997, p. 15]. ❑

CSG

Radical nutrition

Waste disposal is an intractable problem. Solid organic wastes like paper, plastics and food residues give the worst trouble. Ideally, such wastes should be burnt to generate power. But garbage burns poorly giving an acrid smoke. Liquid-phase combustion is better, but needs daunting temperatures and pres-

sures, or expensive reagents such as excited silver ions.

Organic matter in the atmosphere is degraded by hydroxyl radicals. Generated by the action of ultraviolet light on ozone, the ions oxidize or decompose almost every organic molecule. So Daedalus has utilized hydroxyl ions for studies on waste disposal. The radical is perhaps most easily made by irradiating water with gamma rays, which suggests a new use for radioactive wastes. But it can be made by irradiating wet ozone or hydrogen peroxide solution with UV light.

Daedalus's pilot process illuminates an aqueous slurry of organic waste with intense UV light, and pumps in ozone or hydrogen peroxide. The waste is forcefully degraded and broken down by irresistible radical chemistry. But even the strongest UV cannot produce enough hydroxyl ions to oxidize tons of waste completely to carbon dioxide and water. Fortunately, it has not to be done. Daedalus's process needs merely to degrade and oxidize the molecules of the waste sufficiently to render them soluble in water. Oxygen when forced into molecules of the waste, breaks up long chains of molecules and terminates them with hydroxyl or carboxyl groups. The resulting clear soup contains some volatiles, including simple aldehydes and ketones, etc., which can be distilled off for use as solvents. The residual solution contains the involatiles like long-chain fatty acids, polyfunctional alcohols and saccharides, etc.

The oxidized rubbish obtained in the process can be incorporated into pet foods, cattle feed, and so on. Hydroxyl radicals are utterly deadly to viruses and bacteria, making these products quite sterile. [*Nature*, **386** (1997) 661]. ❑

CSG

New piezoelectric materials

The piezoelectric crystals have the unique ability to swell or shrink when zapped with electricity. Engineers have exploited this trait for decades to convert mechanical energy to electricity and back again in applications ranging from phonograph needles to telephone speakers.

Now, the researchers Thomas Shrout and Seung-Eek Park from the Pennsylvania State University have found new piezoelectric materials, having up to 10 times greater effect than that of the current family members. Improvements by a factor of 10 are not easy to come by in a field that is 50 years old and considered mature. The findings can usher in a new generation of piezoelectric devices improving everything from the resolution of ultrasound machines to the range of sonar listening devices.

Piezoelectric materials owe their abilities to the asymmetrical arrangement of positively and negatively charged atoms in their crystal structure. The positive and negative charges balance out in each of the crystal's unit cells. But the positive charges may be weighted towards the top of each cell. An electric field can displace the charges even farther distorting the overall shape of the unit cell and of the crystal as a whole. The process can also run in reverse: Squeezing or stretching the material shifts the charges relative to each other, redistributing electric charge around the surface of the crystal producing a small electric current.

The usual showcase for these properties is a cheap ceramic material called PZT, containing millions of crystalline grains in different orientations. PZT is composed primarily of lead, zirconium, titanium and oxygen. These materials deform by as much as 0.17% in a strong applied electric field. The single crystals of PZT are grown to boost this shape-shifting ability by lining up all the units cells in the same direction so that the contributions to the piezoelectric effect also line up enhancing it. But the PZT's components tend to separate during processing and the ceramic is extremely difficult to grow as single crystals.

To coax the material into forming single crystals, Shrout and Park tried varying its composition. They studied a couple of different mixtures using combinations of lead, zinc, and niobium spiked with varying amounts of lead-titanate (PT). The researchers found that a small admixture of PT (less than 9%) yields materials that not only grow into single crystals, but also end up with piezoelectric abilities that are much more enhanced.

The scientists believe that a part of the enhancement is due to the fact that an electric field applied to the new materials does more than just shift a few atoms around in the unit cell causing the whole crystalline lattice structure to change from one to another. The changed crystal structure, in turn, frees individual atoms to respond more strongly to the field, increasing the overall distortion of the material.

Likewise, a mechanical distortion probably produces a similar lattice shift, enabling the material to generate more current than standard PZT.

The new crystals may presently cost more than ceramics like PZT. But due to enhanced shape changing effects, the materials are likely to find usage in piezoelectric devices. [*Science*, **275** (1997) 1878].❑

CSG

Mechanical motion adds precision to eye surgery

A new surgical technique, called the Hydroblade™ keratome, offers quick and precise cuts, and less cornea trauma to patients undergoing eye surgery. This waterjet cutting technique has been developed by Edison, NJ-based Medjet Inc. The Hydroblade nurtures cornea-tissue healing and stability, and may make corrective lenses obsolete for individuals with myopic, hyperopic, or astigmatic vision impairments.

The approach, already tested on animals and human-donor eyes, is scheduled for minimal testing on blind patients shortly. Surgical blades have been used for forty years to reshape the cornea. The neat waterjet cleave may make blade cutting appear barbaric in comparison and enables more precise correction of the cornea's shape. In addition, less tissue damage may promote more stable healing and less haze, enabling little or no loss of visual acuity.

Vision impairments are corrected by removing just enough tissue from the cornea to make it the shape of a proper lens. The template and cutting plane determine the cornea's final shape. During a typical procedure the ophthalmologist determines the refractive correction in diopters, selects the appropriate cutting head (including the proper template and orifice), and snaps it onto the device.

The doctor uses a microscope to position the template over the center of the cornea. The template applanates or flattens the cornea slightly, while a globe fixation device stabilizes the eye in the instrument.

As the doctor steps on a foot pedal, the template prevents involuntary eye movement. The total cut takes less than one second, and moves so quickly that inertia maintains the cornea's position. The cut removes a contact-lens-shaped piece of tissue with a specific refractive power to correct the patient's vision impairment.

The 30-micron-diameter waterjet uses 1 ml of 'immaculate' water to break only the bonds required to part the tissue in a natural way.

The test system employs a Compumotor 6250 2-axis servo controller that commands the dual axes. SGM brushless dc motors with integral encoders turn lead screws to drive each axis. Medjet used the final positioning parameters, determined experimentally, to design the miniaturized rack-and-pinion system and lead screw for the completely mechanical prototype.

Powering the mechanical motion system is liquid-CO_2 cartridge from which the CO_2 charge is released. An Aerodyne Controls regulator curbs the line pressure at 700 psi. Carbon dioxide gas at 700 psi flows through a plastic tube to the instrument and into a water intensifier. The force of the gas exerted on a 1-inch-diameter piston pressurizes water up to 20,000 psi. At that pressure, the 0.36-micron ruby orifice limits the water's flow rate to about 1 ml/s.

The constant flow rate of the essentially incompressible water makes the intensifier act like a dashpot, maintaining constant piston velocity. A rack-and-pinion gear system converts the piston's linear movement into rotary motion that is transmitted to a lead screw by a steel belt.

The lead screw drives the cutting head at a speed of 10 mm/s and the average scan length is about 8 mm. A typical cut takes less than a second and uses just under 1 ml of water. [*Des News*, **52** (1) (1997) 77]. ❑

CSG

The green way to make mirrors

A new, greener way to make mirrors on-line has been devised and developed by Pilkington and described as an important advance in mirror technology. It allows a reflective surface to be applied to the glass as it is being made on the float line, dispensing with conventional off-line silvering techniques.

The new process is known as Pilkington Reflex and gains its reflectivity from a multi-layer sandwich of ultrathin silicon and silica coatings, rather than the customary metallic film.

The coatings reflect light waves that reinforce each other to produce a mirror. They are applied by chemical vapour deposition while the float glass moves at several hundred metres an hour during manufacture. As fewer chemicals are used and no

precious metals or lead-based backing paints are needed, the new technology is environment friendly.

Mirror glass products, including uncoated flow glass, can now be produced in toughened, bent or laminated form. Also, these products are less likely to be damaged during fabrication, particularly under harsh and humid environments, because they do not weather or deteriorate at the edges in these conditions as can happen with conventionally produced mirrors.

Demand for mirror glass worldwide amounts to 110 million m^2 per year, the third largest market for flat and safety glass after buildings and cars. [*Brit Commerc News*, May/June 1997, p 28]. ❑

CSG

Calcium enriched milk developed

Researchers at the Muji Milk Products, Tokyo, Japan and at the Darsco Foods International, Minnesota, USA have developed a calcium supplemented milk drink that still tastes like milk.

According to researchers, there are two problems with boosting the calcium content of milk. If the supplement is in the form of soluble calcium salts, it gives the milk an odd chalky taste. If the calcium salts are insoluble, they make the drink feel gritty, no matter how small the salt particles are. The problem was solved by using calcium salts present in whey.

The work was initiated with whey, the watery waste product from cheese making. Whey contains calcium salts, mainly phosphate and citrate. These salts were obtained by first removing protein and casein from the whey. The protein is stripped away by ultra filtration, while the casein is precipitated out of solution by 'seeding' it with tiny casein crystals. The remaining solution is then concentrated 10-fold by ultra filtration and mixed with de-fatted milks. The milk retains its characteristic taste and texture because of the unique structure of the calcium salts in the whey. The salts are neither fully in solution nor crystalline, but they have a unique 'net work' structure. As this is not ionic, it cannot react with the proteins in the milk to form precipitate; as it is not crystalline, it will not make the liquid gritty [*Chem Ind*, 12 February 1997, p. 912]. ❑

HKK

One wire technology

Warwick University researchers have developed a DeviceNet technology which cuts wiring and costs while providing a vastly improved means of controlling and monitoring a wide variety of manufacturing processes.

DeviceNet is an open low-cost communication link capable of connecting a wide range of industrial devices for any major assembly process-limit switches, photoelectric sensors, valve manifolds, motors, process sensors, panel displays, and operator interface to a computer network which eliminates all wiring. The technology reduces cost and time to wire and install industrial automation devices. It also provides interchangeability of like components enabling the user to introduce diagnostic tools not previously available in such manufacturing processes.

The technology has attracted lot of interest in the UK and overseas. It has found application in various UK industries including automotive, agriculture, medical, building, marine, and aerospace.

DeviceNet is being used at Marley Building Materials, in a tile factory and at the company's sand plant. Marley claims that the technology has enabled them to cut costs while introducing better quality control and monitoring tools into the process.

The computer hardware and software is now administered by the independent Open DeviceNet Vendor Association (ODVA) which has already established a European Centre to market the technology throughout the world.

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HKK

Fuel and lubrication-oil quality monitored on-site

Researchers at the Oil Test Laboratory, Kittiwake Developments Ltd, West Sussex, UK have developed a fast and simple-to-use system which can monitor quality of fuel and lubricating oils used in large diesel engines in the field.

This complete microprocessor-controlled test facility, which is fully ruggedised and supplied in its own robust steel cabinet, contains all the equipment

required to provide laboratory- standard test results on-site.

Monitoring of fuel oil with the Oil Test Laboratory, could result in savings in fuel costs, and monitoring of fuel and lubricating oils could result in improved operating efficiency and reduced maintenance requirements. Expensive engine and system failures could also be avoided by monitoring trends with tests on lubricating oils.

The laboratory includes a viscometer for verifying that the correct grade or blend of fuel has been delivered and that the fuel is acceptable for storage, pumping and purifiers. When used to monitor changes in lubricating-oil viscosity, it can help to present costly engines failures by indicating contamination by insolubles, water or distillate fuel.

Quantity of fuel delivered can be confirmed with the density meter, which verifies that the fuel grade is correct and can be used with the viscometer to estimate combustion performance.

A compatibility tester can confirm that fuel delivered will remain stable in 'tanks', identify possible stability problems before two fuels are mixed; help to avoid sludge deposits, failure of fuel-handling systems and costly tank cleaning.

Other electronic equipment is supplied for monitoring water in both fuel and lubricating oils and for monitoring lubricating oil for insolubles and total base number.

Comprehensive technical and training manuals which complete the *Oil Test Laboratory*, take the engine through the sequence of testing, explaining results achieved and their interpretations; so that any necessary remedial action can be taken at an early stage.

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HKK

Breakthrough in protein-extraction method

Pharmaceutical scientists at the Cambridge University in collaboration with the researchers of Affinity Technology Limited, UK have found a new way of separating and purifying protein.

The technology allows highly purified proteins to be extracted from cells and other biological sources more economically and easily. This represents a significant advance in the production of pharmaceutical proteins such as interferon, insulin, and factor 8.

The new method allows researchers to separate a particular protein from other compounds using custom-designed compounds which, following immobilization to solid support particles, bind the protein of interest and allow impurities to pass unhindered.

The new adsorbents, sold under the Mimetic trade mark, are very stable, easy to sterilize and quite inexpensive than materials earlier used to purify drug proteins. Their high selectivity minimizes the number of processing steps required to manufacture high-purity proteins and can result in significant cost savings for manufacturers. The new media are so effective that they have been incorporated into some of the world's largest biotechnology manufacturing projects.

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HKK

Innovation management tools

A report entitled, "Innovation management tools: A review of selected methodologies" has been published by the European Innovation Monitoring System (EIMS).

The report is based on studies commissioned by EIMS on the tools and methodologies used by consultants and advisors working with small and medium-sized enterprises to assist them in managing innovation. The main focus is on innovation management tools (IMTs) used within the framework of 'Managing the Introduction of New Technologies' action line of the former SPRINT programme, together with some methodologies of a similar type.

A selection of 17 such tools was classified, the strengths and limitations of the tools assessed, principles of good practice in their use identified, and general conclusions drawn. The study also sought to set the use of these tools in the wider context of support for innovation in firms.

The report and case studies produced as a result of the study should be of interest to consultants, business advisors, consultancy and business support organizations, managers in economic and development agencies, those concerned with the design and implementation of innovation support programmes, and SME managers themselves. A summary of the IMT report is presently available on the WWW at: http.//www.wbs.warwick.ac.uk/esme/imt. [*Cordis Focus*, No. 86, 5 May 1997, p. 15]. ❑

CSG

Euroabstracts

The February 1997 issue of "Euroabstracts", provides information and abstracts of RTD-related publications from the European Community.

The first section gives brief summaries of a number of publications relating to RTD policy within the EU, in third countries and in international organizations. In this issue these include articles on technology watch activities and scientific assessment in different countries, as well as articles about biotechnology, nanotechnology and EUREKA.

"EC Briefing" spotlights a number of recent EU publications, including the Innovation Action Plan, reports and evaluation of the specific programmes, and information on information sources, partnerships and promotion of RTD programmes.

Major features in the February issue look at intellectual property rights for electronic publishing, the CORDIS service, and publications from the Institute for Prospective Technological Studies of the Commission's Joint Research Centre. The "Webwatch" section looks at World Wide Web information services specifically targeted at small and medium-sized enterprises, including the CORDIS SME pages and the European Business and Innovation Centre Network.

Section II includes abstracts of over 300 recent community publications on research, science and technology, covering a wide range of subjects, including: earth sciences; engineering and technology; energy; life sciences; materials; mathematics; computers and telecommunications; nuclear science and engineering and physics. [*Cordis Focus*, No. 86, 5 May 1997, p. 15]. ❑

CSG

The RECORD Project

The RECORD Project (Russia-Europe Cooperation on Rocket Engine Demonstration) was initiated by the French Company SEP in August 1993. The initial proposal called either for the procurement of Russian hardware to be tested in Western Europe or for the execution of tests in Russia, on Russian hardware and specifications from Western industry and delivery to the West of all characteristics of the hardware and of the test results. This operation was to provide European industry with an opportunity to analyze pieces of hardware that would form the next generation of cryogenic rocket engines beyond the Vulcain engine.

Launching of the Record Project comprised the Phase I involving: Technical proposal relative to the modelling of the RD0120 rocket engine, the execution of hot firings on such engines by Chemiautomatics Design Bureau (CADB) and the validation of the models. The plan proposed by SEP in a protocol signed by SEP and CADB includes: The delivery of the full description of the motors necessary for modelling them, with participation of CADB; Preparation of three RD0120 engines for test stand firing and for defining the instrumentation and the test plan; Preparation of the test stands, execution of at least 15 hot firing tests in Russia; Analysis, in cooperation between CADB and its European Partners, of the results and validation of the models set up by West European industry; Inspection of the hardware in cooperation between CADB and its European partners; Delivery of selected components of the RD 0120 for inspection and/or tests by West European partners.

The programme presently involves three parties: The European Union through the Commission of the European Communities, the Russian design bureau 'CADB', European industrial companies organized in a consortium led by SEP, and ESA. The national space agencies are expected to be also involved in future.

The work started in June 1995 and consisted of: Examination of the layout of the RD 0120 engine, of its instrumentation and of its subsystems; Modelling of the overall engine (system level) and first modelling of subsystems; Execution of 2 engine firings and model validation.

Reports were prepared and delivered comparing theoretical predictions and the experimental results, analyzing the differences and proposing an additional measurement plan for the complete programme.

The work led to two rocket firings in August and September 1995 in Russia. The analysis of the results was performed and the results of the planned work were presented at a final meeting for the preliminary phase held in Paris on 30th May 1996. The main result was the empirical adjustment of the theoretical models, selecting the most representative models and determining the experimental coefficients. This was done at system level. The same activity at subsystem level and during transients was left for the main phase (second phase).

The work to be performed during the second phase covers: Framework software for a complete system level mathematical model including detailed models of a few components; Evaluation of test results from three earlier firings and from two new firings; Analysis of pre-burner and thrust chamber transients; Detailed thrust chamber performance analysis; Thermal analysis of nozzle skirt; Transient behaviour of axial balancing system hydraulic analysis of LOx pump; Transient analysis of the regulating system; and Analysis of the electric throttle valve.

All these activities form a self-standing and technically useful set of tasks to be executed while the framework for the continuation of RECORD beyond 1997 is set up.

The RECORD project is of particular interest both to ESA and to the European space industry as it allows: Receipt of test results on a type of rocket motor that is known, theoretically, to provide particularly high performance but that could not be built in Western Europe because its advanced technology is too expensive and therefore not adapted to expendable launchers like Ariane-5; Receipt of design data that will allow a mathematical modelling of the motor and to develop an understanding of how the Russian motor was designed and optimized; Comparison of the predictions of the mathematical model with experimental results, which provides values for empirical factors, and estimates the safety margins judged to be necessary by the Russians; Precise determination of the level reached by Russian technologies, showing in particular what is feasible and within reach in a suitably oriented technology programme.

The RECORD project is a unique opportunity for European industry to acquire hands-on experience on a type of motor that represents the next technological step that Europe will have to master to remain competitive in the launcher field. The acquired experience will have its full synergetic effect when the VEDA (Verification Engine for Development Advances) programme is started. VEDA will deal with high-pressure technologies but in the lower thrust range so that bringing together the RECORD technologies and the VEDA technologies will provide Europe with experience over the whole thrust range. [*Reaching for the Skies*, ESA, No. 16, Jan 1997, pp. 11-14]. ❑

CSG

Report of the Working Groups of Information Society Forum of the European Commission

The European Commission decided to set up the Information Society Forum in February 1995 in order to create a new and authoritative source of reflection, debate and advice on the challenges of the Information Society.

The Forum consists of 128 members drawn from five main fields of activity:

- Users of the new technologies: industry (banks' retail, maritime etc), public services, consumer groups, small and medium-sized enterprises and the professions
- Social groups: academics, employers organisations and trade unions, youth groups, regional and city representatives
- Content and service providers: publishers and authors, film and TV producers, broadcasters, computer software producers and information service providers
- Network operators: fixed telecommunications, cable TV, mobile and satellite operators
- Institutions: members of Parliament, of the Economic and Social Committee of the Committee of the Regions and the data protection Commissioner.

Six working groups have been formed whose members have given their views under the following heads:

- the impact on the economy and employment;

- basic social and democratic values in the "virtual community,"
- the influence on public services
- education, training and learning in the Information Society
- the cultural dimension and the future of the media
- sustainable development, technology and infrastructure

The European Commission has published the first Annual Report and the supplementary report (working group's reports) which can be obtained from the Information Society Forum Secretariat (European Commission, Information Society Activity Centre, 200 Rue de la Loi, BU 24, 2/70, B-1049 Brussels. The full texts are also available on the ISPO web server at: URL: http:/vww. ispo. cec be/infoforurm/pub.html

Summary of the report of Working Group III under the head "Influences on Public Services" is given in this issue. The other reports of the Working Groups will be covered in subsequent numbers of JSIR one in each issue.

Summary of Report of the Working Group 3: Influences on Public Services

Background

The public sector provides important services to citizens and enterprises. The scope and breadth of these public services differs from one Member State to another. Strategic services provided by public authorities include justice, defence, research, education, physical infrastructure, environment, health and social services.

The notion of the public sector covers national ministries and agencies as well as the regional and local authorities.

Intensive introduction and use of the Information and Communications Technologies (ICT) will play an important and fundamental role in:

- bringing public services nearer to the citizen;
- offering interactive public services to households and/or making them available at natural meeting-points for people;
- improving the internal efficiency and reducing the costs of the public sector while at the same time improving the quality of public services;
- establishing an information infrastructure which will contribute to economic and social development;
- contributing to the dissemination of ICT to SME's;
- stimulating the development of products and services in the content, software and hardware industries.

The adaptation of the public sector to the Information Society will have a considerable impact on the economy, social welfare and the democratic process.

Obstacles to be removed

A series of obstacles need to be removed in order to facilitate the introduction of ICT in the public sector. Public administrations are not known as flexible and dynamic organisations and cultural, managerial and organisational changes will be required. The process of change will depend upon governments acting to modernize and improve management and administrative processes. In some cases, the new ICT will require a radical transformation of administrative work. It will also enable public services to be performed in new ways.

Existing public sector information systems and databanks were often developed without any thought to giving the general public easy access. This means that many of them will have to be restructured and re-engineered in order to be useful vehicles for disseminating information and providing new services for citizens and enterprises.

The right to access public information has to be clarified, including the question of who will decide which kind of information is to be provided, to whom and at what cost. In addition, uncertainty has to be removed about privacy and the degree of protection to be maintained. Issues of copyright of public information also have to be dealt with.

If the full potential of ICT is to be realised, co-operation and integration within the public sector has to be increased and also between European, national, regional and local administrations. Interoperability between information-systems has to be assured. ICT standardisation has to meet this challenge.

Finally, in the short term the lack of awareness among civil servants and budget constraints may slow down the entry of the public sector into the Information Society.

Actions to be undertaken

EU-wide actions should be undertaken in four areas:

- raising the awareness of administrations of the potential of ICT and of its enabling forces.
- coordinating policies relating to the Information Society and public services
- ICT-standardisation to enable trans-national interoperability between public sector information systems
- legislation to give citizens access to public information while at the same time protecting privacy.

Awareness-raising actions have to be stimulated further, in particular through EU-wide demonstration projects, training programmes for public managers and civil servants and strategic initiatives and programmes such as electronic commerce and tendering for the public sector, trans-national interchange of information between administrations, European Citizens electronic Card and Citizens Information Systems.

An urgent need is to encourage Member States both to appoint an authority coordinating actions relating to the Information Society and public services, and to create an advisory body for debating strategic issues in this field.

ICT-standardisation has to focus on the functional specifications of systems in order to assure interoperability between administrations and between them and the external world. Standardisation will play an especially crucial role in stimulating applications for use in *tele-medicine, transport and electronic commerce*.

In the legislative area, a legal framework should be urgently developed which delivers full rights of access for citizens to public information. In addition, the concept of universal services has to be extended to the content of public information. The obligations of public bodies and the relationship between public and private actors have to be defined. Public information may be a source of value added to private actors and a stimulus to the European content industry. [First Annual Report to the European Commission from the information Society Forum Secretariat, European Commission, Information Society Activity Centre, 200 Rue de la Loi, BU 24, 2/70, B-1049 Brussels].

Announcement

INSUCON/ISOTECH'98

A 2-day INSUCON conference to overview the achievements and identify future needs of power engineering industry and a one-day ISOTECH symposium describing best practice for insulation manufacture and applications in rotating machines, are to be organized by BEAMA at Harrogate International Centre during 12-14 May 1998.

Papers on electrical insulation may be submitted covering the subject areas: Rotating machines; Transport; Transmission and distribution equipment; Transformer; and Switchgear. In particular, the scope may cover areas such as: Application of basic dielectrics science to insulation technology; New materials development, production, assessment and application; Ageing phenomena and evaluation of in service insulation systems; Environmental aspects such as flammability, toxicity, biodegradability and remediation; Analytical techniques for assessing insulation quality and capability; and Condition monitoring, diagnostic testing.

Further details and the INSUCON/ISOTECH'98 registration card may be obtained from:

P R Department
BEAMA, Westminster Tower
3 Albert Embankment
London SE1 7SL
United Kingdom. □

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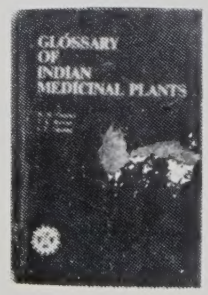

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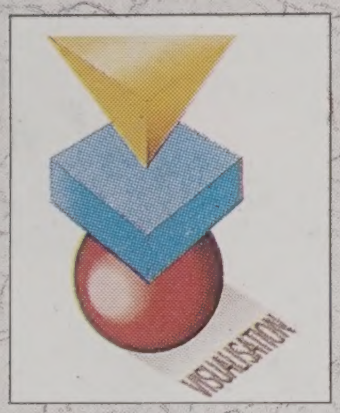

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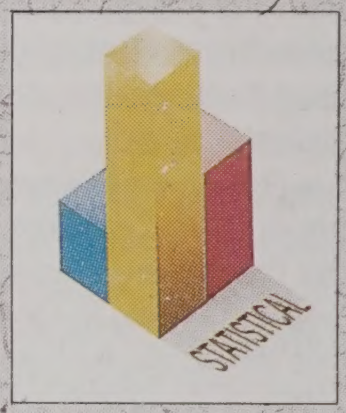

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